The land Mollusca (Gastropoda) of Saint Kitts and Nevis (Lesser Antilles), with description of a new species

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ABSTRACT

An overview of the land snail fauna of the Lesser Antillean islands of Saint Kitts and Nevis is given, based on data from literature and two recent surveys. There are 33 taxa listed, of which 26 are from Saint Kitts and 22 from Nevis. One taxon is described as new: *Bulimulus ouallensis* Breure and Hovestadt. Furthermore, the following taxa are recorded from these islands for the first time: *Bulimulus diaphanus fraterculus* (Potiez and Michaud, 1835), *Obeliscus swiftianus* (Pfeiffer, 1854), and *Zonitoides arboreus* (Say, 1817). Four taxa—*Diplosolenodes* sp., *Pallifera* sp., and two *Succinea* species—could only be identified to the genus level. Three taxa, previously thought to occur on the islands, are now removed from their faunal lists, due to inaccuracies of provenance of specimens or misidentifications. Finally, remarks are given on the distribution and conservation status of species collected during the surveys.

Additional Keywords: Taxonomy, distribution, islands, West Indies

INTRODUCTION

The Reverend Smith stands in the time-honored tradition as a parson-naturalist (Armstrong, 1990). As a clergyman, he spent five years on Nevis, summarizing his findings in a 1745 book entitled: "A natural history of Nevis and the rest of the english Leeward Charibee Islands in America with many other observations on nature and art; particulary an introduction to the art of decyphering in eleven letters etc.' He begins with observations on marine shells, but there is no reference whatsoever to the non-marine malacofauna.

The first overview of the land shells from Saint Kitts and Nevis was published in 1862 by Thomas Bland. For Saint Christopher, the oldest English name given to the island of Saint Kitts, he listed six species in his 'Catalogue of the Land Shells of the West Indian Islands'; Nevis was not mentioned at all. Bland (1862: 361) wrote "[t]he names of several islands do not appear in the Catalogue, because I am ignorant as to the species inhabiting them".

The first mention of an endemic species for either Saint Kitts or Nevis was by Henry A. Pilsbry, who in 1889 described *Helix josephinae* var. *nevisensis* [now *Pleurodonte josephinae nevisensis*]; the specimen had been collected by Frederick Albion Ober. The latter being a very prolific writer and traveler, he regrettably did not mention his activities in Nevis in any detail.

William H. Rush visited Saint Kitts in 1891. His methods are still useful today: "Carriage hire was too expensive and the time at my disposal too short for any extended trip, so footing it was resorted to as the only way to reach reasonably near hunting grounds. In this manner the deep gorges up in the mountains of St. Kitts, at an elevation of one or two thousand feet were visited (....) Many specimens of *Bulimulus*, *Helicina* and *Amphibulima* were taken".

Pieter Wagenaar Hummelinck visited Saint Kitts and Nevis twice, in 1949 and 1955, but apparently restricted his collecting to the coastal areas (Figure 4). His surveys provided the raw data for publications on the Vertiginidae (Haas, 1960), Subulinidae and Oleacinidae (Haas, 1962), and Bulimulidae (Breure, 1974).

Figure 1. West Indies, showing location of Saint Kitts and Nevis (red circle). Source: Wikimedia.

Saint Kitts and Nevis is a federative, two-island state in the West Indies (Figures 1–3), and constitutes part of the British Commonwealth. The total area is 269 km^2, of which Saints Kitts acounts for 176 km^2 and Nevis 93 km^2.

The highest elevation on Saint Kitts is Mount Liamuiga (1156 m, also known as Mount Misery), and on Nevis it is Nevis Peak (985 m). Annual average rainfall is 1625 mm and 1170 mm respectively. On Saint Kitts, the rainfall is fairly evenly distributed over the island except for the Southeast Peninsula, which has a very dry climate.

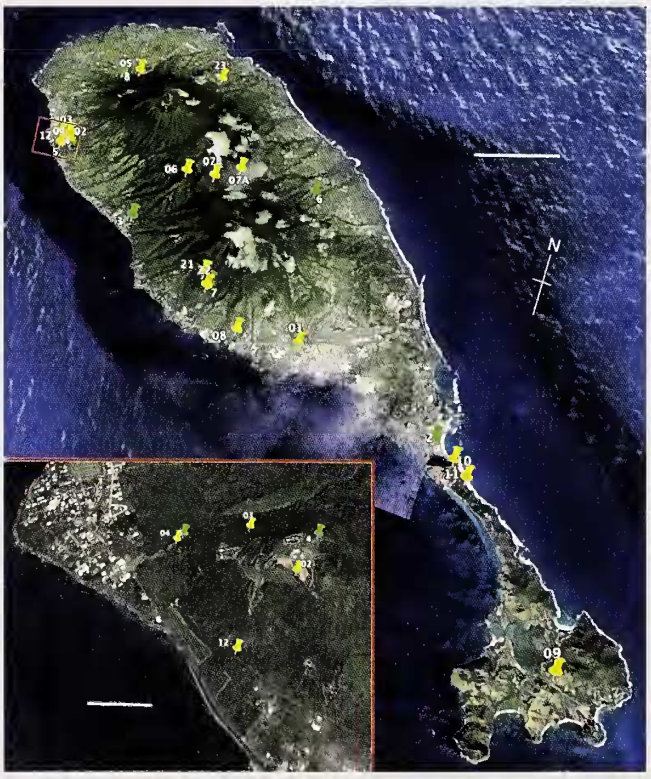


Figure 2. Saint Kitts. Localities sampled in 2004 (yellow pins), respectively 2014 (green pins); scale = 2.5 km. Detail of area around Brimstone Hill within red quadrant; scale = 250 m. Source: Google™ Earth Pro. Image Landsat. © 2015 Google.

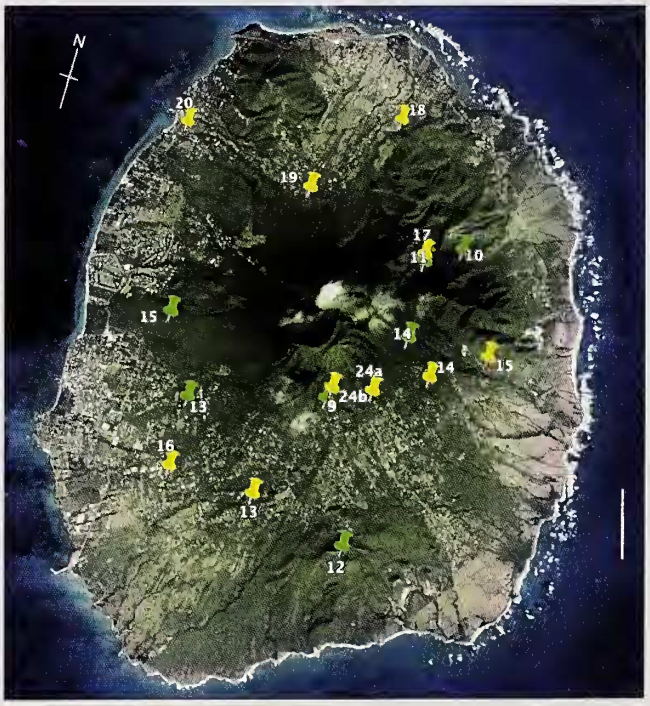


Figure 3. Nevis, with localities sampled in 2004 (yellow pins), respectively 2014 (green pins); scale = 1.0 km. Source: Google™ Earth Pro. Image Landsat. © 2015 Google.

From August to November there is a relatively wet season and a drier season from mid-January to April. On Nevis, rainfall is lowest on the eastern side and increases with altitude. Most rain falls between July and January (all data from Anonymous, 1991).

Geologically both islands belong to the western chain of the Lesser Antillean archipelago north of Dominica, which includes the islands of Basse Terre (Guadeloupe), Montserrat, Redonda, Nevis, Saint Kitts, Saint Eustatius, and Saba. These islands consist mostly of volcanic rocks and remain seismically active, but geological knowledge about them remains based mainly on older sources. Saint Kitts has a core of Eocene andesite, and three younger volcanic centers which were active during the Pleistocene. Mt. Liamuiga is a stratovolcano with a deep summit crater of over 300 m diameter and, together with the other volcanic centers, are aligned along the length of the island on a NW–SE trend. A small area of Plio-Pleistocene limestone can be found at Brimstone Hill and at Godwin Ghaut above 330 m (Trechmann, 1932; Martin-Kaye, 1959; Westermann and Kiel, 1961; Anonymous, 1991; Toothill et al., 2007). The oldest rocks of Nevis are of marine origin, but the island is comprised mainly of dacites, with andesites in a number of places. Limestone can be found on the southern slopes of Saddle Hill (Westermann and Kiel, 1961; Hutton, 1968; Hutton and Nockolds, 1978).

Table 1. Localities mentioned in this paper.

Island	Locality	Alt.	1949	2004	2014	LAT	LON
STK	St. George, Basseterre, La Guérite	50	419	01		17.299472	−62.732917
	St. Thomas, midway up Brimstone Hill	175		02		17.34625	−62.836056
	St. Thomas, lower slope of Brimstone Hill	129		03		17.348306	−62.837639
	St. Thomas, base of Brimstone Hill	47		04		17.348194	−62.840583
	St. Paul, crater trail up Mt. Liamuiga	327		05		17.382694	−62.826806
	St. Thomas, trail to D'Os Dane Pond	556		06		17.345	−62.790417
	Christchurch, trail to Phillips Level	438		07A		17.352944	−62.774111
	Christchurch, trail from Phillips to Phillips Level	463		07B		17.346278	−62.780806
	Trinity, Mattingly Flower Farm	66		08		17.29725	−62.752028
	St. George, road to Turtle Beach, south of Salt Pan	39		09		17.236306	−62.640556
	St. George, Friars Beach Bay	8		10		17.276861	−62.674139
	St. George, road south of Basseterre	79		11		17.280583	−62.678722
	St. Thomas, railway cut at base Brimstone Hill	44		12		17.34375	−62.838278
	Trinity, top of Ottley's Level	490		21		17.310611	−62.768556
	Trinity, base of Ottley's Level	290		22		17.307139	−62.766222
	St. John, Lavington Ghut	189		23		17.391	−62.797861
	North Frigate Bay, Sugar Bay Club	11			2	17.286972	−62.685083
	Romney Manor	61			3	17.326833	−62.800806
	St. Thomas, Brimstone Hill, near barracks	221	421		4	17.347806	−62.835
	St. Thomas, NW side Brimstone Hill	78	422		5	17.348583	−62.840194
	Trinity, Ottley Plantation House	155			6	17.357028	−62.7475
	Trinity, along track to Ottley Level	342			7	17.310389	−62.765444
	St. Pauls, trailhead to Liamuiga	257			8	17.382861	−62.832556
	St. George, E Basseterre, Morne Hills	45	417			17.297564	−62.699269
	Wingfield River, 300 m N bridge	50?	420			17.322917	−62.802783
NEV	St. John, Montpellier Estate, botanical garden	190		13		17.123028	−62.594056
	St. George, Golden Rock	294		14		17.145306	−62.567306
	St. George, Frenchman's Cave	164		15		17.150083	−62.557611
	St. John, Experimental Station, greenhouse	80		16		17.125556	−62.608972
	St. James, above Prison Farm, cloud forest	269		17		17.165611	−62.571
	St. James, above Prison Farm, cloud forest	188			10	17.169389	−62.563611
	St. James, above Prison Farm, cloud forest	255			11	17.166444	−62.57025
	St. James, Camp's River	69		18		17.189361	−62.578472
	St. James, Spring Hill, stunted forest	231		19		17.174667	−62.592694
	St. Thomas, Westbury, greenhouse	17		20		17.184028	−62.617083
	Herbert Heights, trail up Nevis Peak	367		24a		17.141806	−62.576528
	Herbert Heights, trail up Nevis Peak	467		24b		17.141306	−62.583278
	St. George, surroundings of Peak Heaven	466			9	17.141528	−62.583389
	Saddle Hill	364			12	17.118861	−62.577139
	Hamilton Estate ruins	153			13	17.138889	−62.607194
	St. George, N of Golden Rock Inn, along Source trail	445			14	17.153139	−62.571167
	Montraves Estate	103			15	17.152528	−62.612889
	West of Jessops Village	1	414			17.164553	−62.628825
	Near Mosquito Bay	30	415			17.202333	−62.609386
	Jones River, E of Newcastle	15?	416			17.200728	−62.578408

Vegetation types occurring on the two islands have been extensively described by Lindsay and Horwith (1999) based on a modification of Beard (1949). Helmer et al. (2008) compared the data from Beard (1949) with recent data and calculated the change in land cover data based on satellite imagery.

The aim of this paper is to present the combined results of two malacological surveys, respectively conducted in 2004 (by D.G. Robinson and collaborators) and 2014 (by A. Hovestadt), and to summarize the malacofauna of these islands.

MATERIALS AND METHODS

Both above-mentioned, recent surveys yielded data on 40 localities in total. Localities are presented with their coordinates as they were recorded by D.G. Robinson and collaborators (field work during 2004) and A. Hovestadt (field work during 2014) respectively (Table 1). Altitudes for the former have been taken from Google Earth v.7.1.2.2041. Coordinates of these localities were plotted in SimpleMappr (Shorthouse, 2010) and exported as KML file. For historical comparisons, the localities sampled by P. Wagenaar Hummelick (1949) have been added in Table 1; coordinates of these (estimated from Google Earth) are based on his map (Figure 4; Wagenaar Hummelinck, 1953: 20–21, Figure 19), and are less precise than the recent ones. The species occurrence data for these localities are only partial (Haas 1960, 1962; Breure, 1974).

The above genus-levels taxonomy follows Bouchet et al. (2005). Under each species, references are made only to the literature including records from Saint Kitts and Nevis.

The diversity of sampled localities was analyzed to determine "hotspots" of land snail diversity on the two islands, following the same method as applied by Robinson et al. (2009) for Dominica. When more species are present in a given locality, also rare species will be better represented. Therefore, each occurrence was given a "rareness factor" (R = 1/L; L equals the number of localities where a species is present). R varies in this study from 0.025 (the species occurs at all 40 localities where molluscs have been collected) to 1.000 (the species occurs at a single locality only). Finally, the diversity per locality is calculated, both as total and for endemic species only ($D_{tot} = \Sigma R_{tot}/S$; $D_{end} = \Sigma R_{end}/S$; S, species richness as the number of species per locality). Localities sampled by Wagenaar Hummelinck, with partial species occurrence data, have been excluded from these calculations.

Abbreviations for depository collections are: AH, collection of A. Hovestadt, Amersfoort, the Netherlands; ANSP, Academy of Natural Sciences of Philadelphia, Philadelphia, USA; FMNH, Field Museum of Natural History, Chicago, USA; RMNH, Naturalis Biodiversity Center (formerly Rijksmuseum van Natuurlijke Historie), Leiden, the Netherlands; SMF, Senckenberg Natur-Museum, Frankfurt am Main, Germany; UF, Florida State Museum of Natural History, Gainesville, U.S.A.; USDA, United States Department of Agriculture, Animal and Plant Health National Malacology Collection, ANSP, Philadelphia, USA. Other abbreviations are: leg., for "collected by," and "coll." for "Collection." An asterisk (*) indicates an observation only, material not collected.

Figure 4. Saint Kitts and Nevis, localities sampled in 1949 (Wagenaar Hummelinck, 1953: fig. 16).

SYSTEMATICS

Superfamily Helicinoidea *sensu* Thompson, 1980
Family Helicinidae Férussac, 1822

Genus *Helicina* Lamarck, 1799

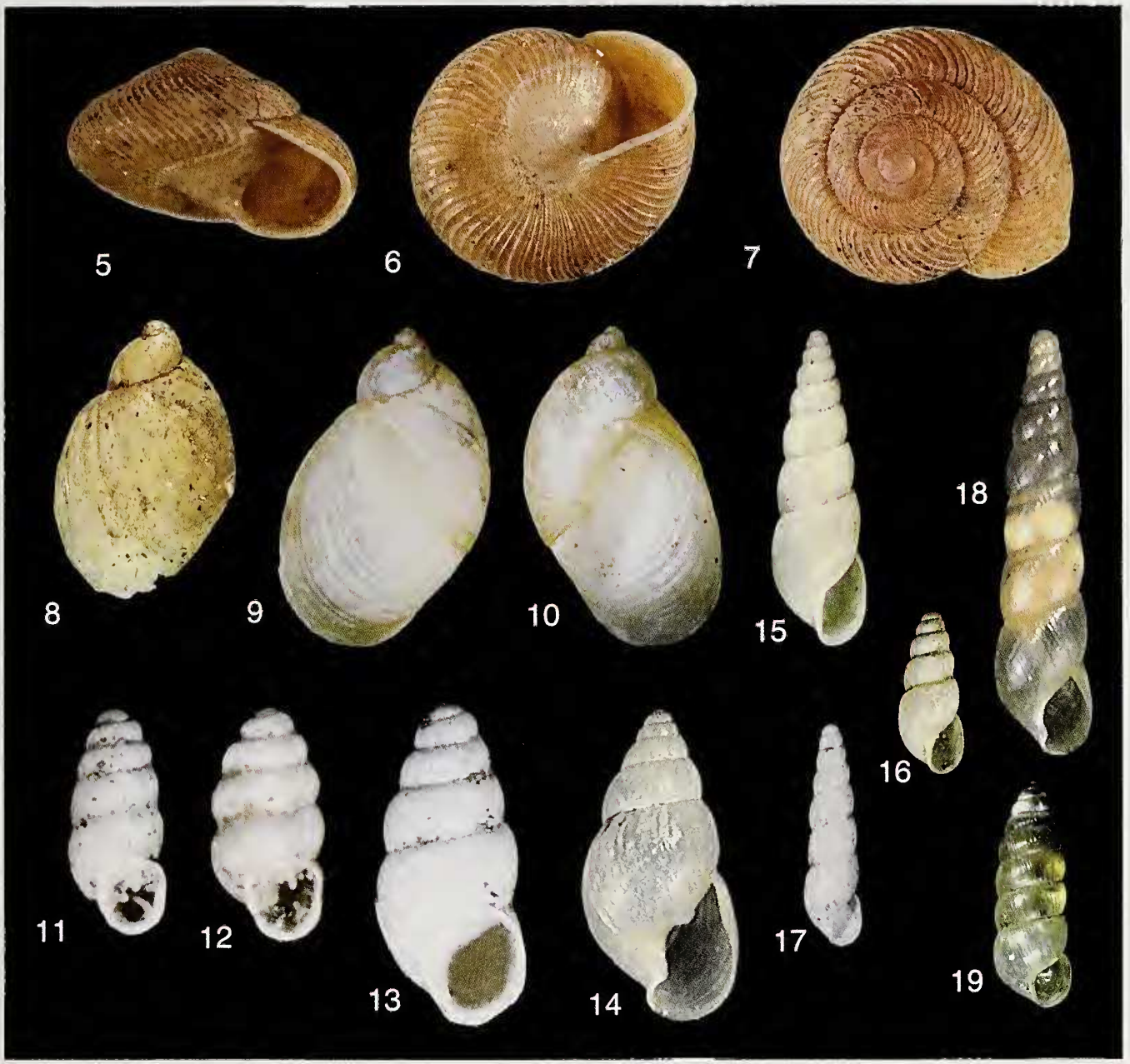
Helicina fasciata Lamarck, 1822
(Figures 20, 22–23)

Helicina fasciata Lamarck, 1822.—Bland, 1862: 358 (St. Christopher); Clench, 1956: 69 (St. Kitts, Nevis).

Survey Material: **St. Kitts:** Christchurch, Nichola Town Parish, trail to Phillips Level, (USDA); St. Thomas, Middle Island Parish, trail to D'Os Dane Pond (USDA); Trinity, Palmetto Point Parish, top of Ottley's Level (USDA); ibid., near base of Ottley's Level (USDA); **Nevis:** St. George, Gingerland Parish, Golden Rock (AH; USDA); ibid., Herbert Heights, trail to Nevis Peak (USDA); ibid., near Peak Heaven (AH); St. James, Windward Parish, above Prison Farm, cloud forest (AH; USDA).

Additional Material Examined: **St. Kitts:** ex Swift coll. (ANSP 14914); W.H. Rush leg., 1891 (ANSP 62064). **Nevis:** C.A. Barber leg. (ANSP 78304); ibid., J. Bond leg., 1929 (ANSP 149430).

Distribution: Lesser Antilles, where it is widespread as a result of human activities.



Figures 5–19 Helicinidae, Succineidae, Vertiginidae, and Subulinidae species. **5–7.** *Lucidella (Poeniella) plicatula christophori* (Pilsbry, 1897), H = 4.2 mm. **8.** *Succinea* species A, H = 9.3 mm. **9–10.** *Succinea* species B, H = 11.3 mm. **11.** *Gastrocopta rupicola marginalba* (L. Pfeiffer, 1840), H = 2.2 mm. **12.** *Gastrocopta servilis* (Gould, 1843), H 2.3 mm. **13.** *Pupoides marginatus nitidulus* (L. Pfeiffer, 1839), H = 3.6 mm. **14.** *Leptinaria unilamellata* (d'Orbigny, 1837), H = 10.6 mm. **15.** *Allopeas gracile* (Hutton, 1834), H = 7.0 mm. **16.** *Allopeas micra* (d'Orbigny, 1835), H = 6.0 mm. **17.** *Obeliscus swiftianus* (L. Pfeiffer, 1854), H = 7.2 mm. **18.** *Subulina octona* (Bruguière, 1789), H = 19.7 mm. **19.** *Beckianum beckianum* (L. Pfeiffer, 1846), H = 6.9 mm.

Habitat: Occurs in a wide range of habitats, from relatively undisturbed (cloud forest) to disturbed (area with *Heliconia* plants).

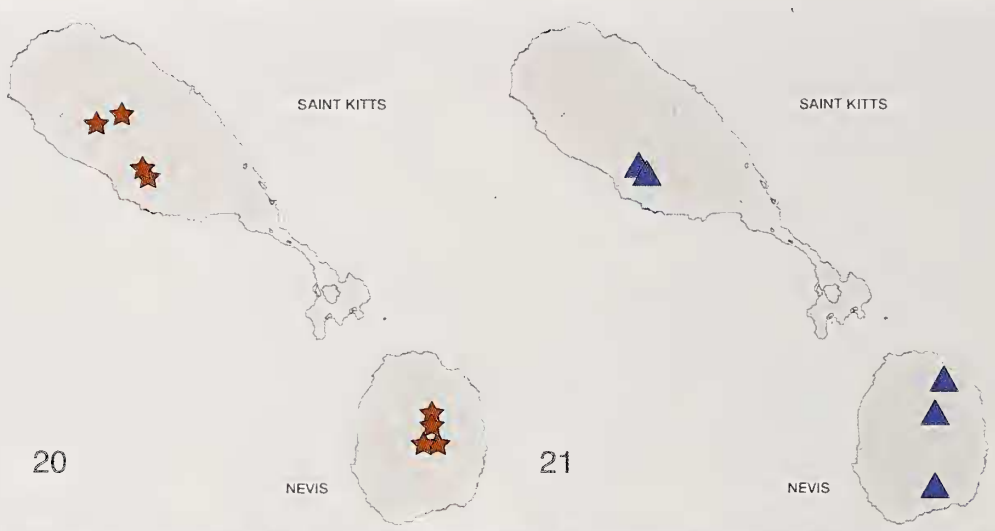
Remarks: This species exhibits a marked preference for humid conditions in dense vegetation (e.g., humid scrub forest, cloud forest), being particularly abundant on the upper slopes of Nevis Peak. It shows a high variety of colors, even in specimens within the same population.

Genus *Lucidella* Swainson, 1840

Subgenus *Poeniella* H.B. Baker, 1923

***Lucidella (Poeniella) plicatula christophori* (Pilsbry, 1897)**
(Figures 5–7, 21)

Helicina plicatula var. christophori Pilsbry, 1897: 118 (Type locality: St. Kitts).



Figures 20–21. Distribution of Helicinidae. **20.** *Helicina fasciata* Lamarck, 1822 (red star). **21.** *Lucidella (Poenilla) plicatula christophori* (Pilsbry, 1897) (blue triangle).

Helicina christophori Pilsbry, 1897.—H.B. Baker, 1923: 23.
Lucidella plicatula christophori (Pilsbry, 1897).—Boss and Jacobson, 1974: 31.

Survey Material: **St. Kitts:** Trinity, Palmetto Point Parish, top of Ottley's Level (USDA); ibid., near base of Ottley's Level (USDA); **Nevis:** St. James, Windward Parish, above Prison Farm, cloud forest (USDA); ibid., Camp's River (USDA); St. George, Gingerland Parish, Saddle Hill (AH).

Additional Material Examined: **St. Kitts:** W.H. Rush leg. (ANSP 62062, lectotype); ibid. (ANSP 358494, paralectotypes).

Distribution: Saint Kitts, Nevis.

Habitat: It is believed to live in damp leaf litter and under rotting logs.

Remarks: This species appears to be relatively rare, as we found only empty shells.

Superfamily Veronicelloidea Gray, 1840
Family Veronicellidae Gray, 1840

Genus *Diplosolenodes* Thomé, 1975

***Diplosolenodes* species**
(Figure 27, 31)

Survey Material: **Nevis:** St. George, Gingerland Parish, Herbert Heights, trail to Nevis Peak (USDA).

Remarks: There is insufficient material to determine if this is a more widespread species occurring on other Antillean islands.

Genus *Veronicella* de Blainville, 1817

***Veronicella cubensis* (L. Pfeiffer, 1840)**
(Figures 26, 31)

Survey Material: **Saint Kitts:** St. Thomas, Middle Island Parish, fortifications midway up Brimstone Hill (USDA); Trinity, Palmetto Point Parish, Ottley Plantation House (AH*); **Nevis:** St. George, Gingerland Parish, Golden Rock (USDA).

Distribution: Cuba, Hispaniola, Puerto Rico, Antigua, Saint Kitts, Nevis, Dominica, Barbados. Introduced to various Pacific islands (Hawaiian Islands, Guam, northern Marianas).

Remarks: Robinson et al. (2009) mentioned this species from Saint Kitts and Nevis, without providing further evidence. Although it has been reported as a serious agricultural pest (especially on Pacific islands), this species is of no such concern at the moment on these two islands.

***Veronicella* aff. *floridana* (Leidy *in* Binney, 1851)**
(Figures 25, 31)

Survey Material: **Saint Kitts:** Trinity, Palmetto Point Parish, nursery of Mattingly Flower Farm (USDA); ibid., top of Ottley's Level (USDA); **Nevis:** St. John, Figtree Parish, Montpellier Estate, botanical garden (USDA).

Distribution: Florida, throughout the West Indies.

Remarks: This invasive slug species is here reported from Saint Kitts and Nevis for the first time. It has become an agricultural pest in other parts of the West Indies, where it feeds on a wide range of species. Dissection is required to accurately identify this and the previous species, as the two can bear some morphological similarity.

Superfamily Succineoidea Beck, 1837

Family Succineidae Beck, 1837

Figures 22–30. Living snails of the families Helicinidae, Philomycidae, Veronicellidae, Streptaxidae, Subulinidae, and Pleurodontidae. **22–23.** *Helicina fasciata* Lamarck, 1822. **24.** *Pallifera* species. **25.** *Veronicella* aff. *floridana* (Leidy *in* Binney, 1851). **26.** *Veronicella cubensis* (L. Pfeiffer, 1840). **27.** *Diplosenodes* species. **28.** *Streptartemon glaber* (L. Pfeiffer, 1849). **29.** *Subulina octona* (Bruguière, 1789). **30.** *Pleurodonte josephinae nevisensis* (Pilsbry, 1889).

Genus *Succinea* Draparnaud, 1801

***Succinea* species A**
(Figures 8, 32)

Survey Material: **Saint Kitts:** St. George, Basseterre, road south of Basseterre (USDA).

Remarks: The taxonomy of West Indian succinids is poorly understood, and a revision is long overdue. Not many anatomical or molecular studies have been made on this group, and various names have been used indiscriminately by malacological workers over the centuries for snails on different Antillean islands.

***Succinea* species B**
(Figures 9, 10, 32)

Material Examind: **Nevis:** St. John, Figtree Parish, Prospect, greenhouse of Experimental Station (USDA); St. Thomas Lowland, greenhouse of Taiwanese technical Mission (USDA).

Distribution: Florida, Puerto Rico, Nevis.

Remarks: This species was likely introduced with horticultural imports from southern Florida or from Puerto Rico, as it closely resembles material found in greenhouses in those areas.

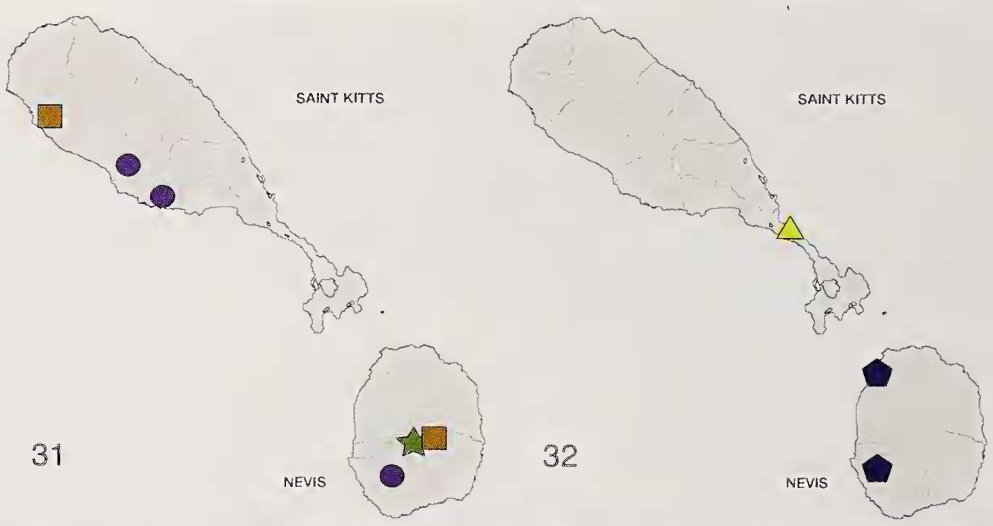
Superfamily Achatinoidea Swainson, 1840

Family Subulinidae P. Fischer and Crosse, 1877

Genus *Allopeas* H.B. Baker, 1935

***Allopeas gracile* (Hutton, 1834)**
(Figures 15, 33)

Lamellaxis (Allopeas) gracile (Hutton [, 1834]).—Haas, 1962: 56; St. Christopher, Brimstone Hill; Nevis: Jessops Village.



Figures 31–32. Distribution of Veronicellidae and Succineidae. **31.** *Diplosolenodes* sp. (green star), *Veronicella cubensis* (L. Pfeiffer, 1840) (orange rectangle), and *Veronicella* aff. *floridensis* (Leidy in Binney, 1851) (purple circle). **32.** *Succinea* sp. A (yellow triangle), *Succinea* sp. B (dark blue polygon).

Survey Material: **Saint Kitts:** St. George, Basseterre Parish, Basseterre, La Guerite, Department of Agriculture (USDA); ibid., road south of Basseterre (USDA); St. Thomas, Middle Island Parish, base of Brimstone Hill (USDA); ibid., near barracks (AH); **Nevis:** St. George, Gingerland Parish, Saddle Hill (AH); ibid., Montravers Estate (AH); St. John, Figtree Parish, Montpellier Estate, botanical garden (USDA).

Distribution: West Indies, southern Mexico, Central and South America; distributed throughout the subtropics worldwide.

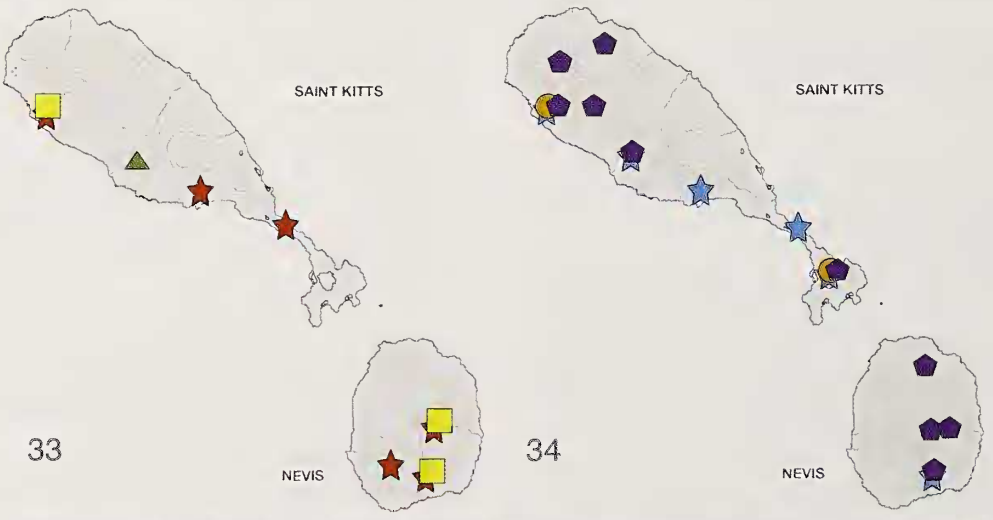
***Allopeas micra* (d'Orbigny, 1835)**
(Figures 16, 34)

Lamellaxis (Allopeas) micron (d'Orbigny, [1835]).—Haas, 1962: 57; St. Christopher, Brimstone Hill; Morne Hills.

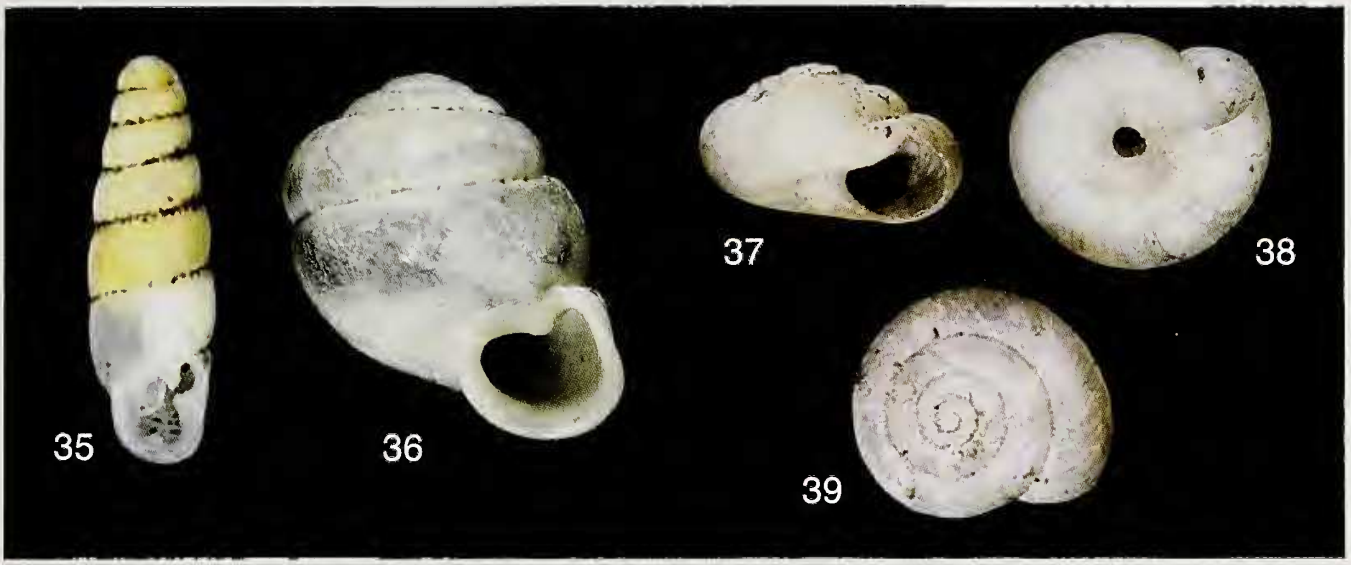
Survey Material: **Saint Kitts:** St. George, Basseterre Parish, Basseterre, La Guerite, Department of Agriculture (USDA); ibid., road to Turtle Bay, south of Salt Pan (USDA); ibid., road south of Basseterre (USDA); St. Thomas, Middle Island Parish, lower slope of Brimstone Hill (USDA); ibid., NW-side Brimstone Hill (AH); Trinity, Palmetto Point Parish, near base of Ottley's Level (USDA); **Nevis:** St. George, Gingerland Parish, Saddle Hill (AH).

Distribution: West Indies, Mexico to Bolivia.

Remarks: The specimens found are up to 6 mm in height.



Figures 33–34. Distribution of Subulinidae. **33.** *Allopeas gracile* (Hutton, 1834) (red star), *Beckianum beckianum* (L. Pfeiffer, 1846) (yellow rectangle), *Leptinaria unilamellata* (d'Orbigny, 1837) (green triangle). **34.** *Allopeas micra* (d'Orbigny, 1835) (light blue star), *Obeliscus swiftianus* (L. Pfeiffer, 1853) (orange circle), *Subulina octona* (Bruguière, 1789) (purple polygon).



Figures 35–39. Streptaxidae and Sagdidae species. **35.** *Huttonella bicolor* (Hutton, 1834), H = 6.0 mm. **36.** *Streptartemon glaber* (L. Pfeiffer, 1849), H 6.8 mm. **37–39.** *Hojeda* species, D = 4.5 mm.

Genus *Beckianum* H.B. Baker, 1961

***Beckianum beckianum* (L. Pfeiffer, 1846)**
(Figure 19, 33)

Diaopeas beakianum (L. Pfeiffer [, 1846]).—Haas, 1962: 55. St. Christopher, La Guérite; Nevis, near Jessops Village.

Survey Material: **Saint Kitts:** St. Thomas, Middle Island Parish, lower slope of Brimstone Hill (USDA); ibid. base of Brimstone Hill (USDA); ibid., near barracks and on NW side of Brimstone Hill (AH); **Nevis:** St. George, Gingerland Parish, Montraves Estate (AH); St. John, Figtree Parish, Saddle Hill (AH).

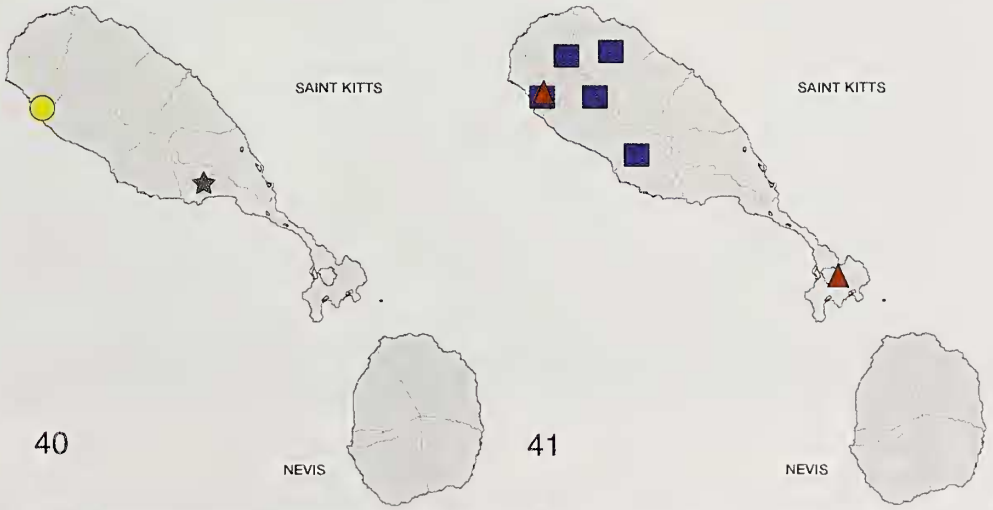
Distribution: West Indies, Central America.

Remarks: Material collected was up to 9 mm in height. This is the first report of this taxon from Nevis.

Genus *Leptinaria* Beck, 1837

***Leptinaria unilamellata* (d'Orbigny, 1837)**
(Figures 14, 33)

Survey Material: **Saint Kitts:** Trinity, Palmetto Point Parish, top of Ottley's Level (USDA). **Nevis:** St. George, Gingerland Parish, Golden Rock (USDA); ibid., Frenchman's Cave (USDA); Herbert Heights, trail to Nevis Peak (USDA).



Figures 40–41. Distribution of Streptaxidae and Gastrocoptidae. **40.** *Huttonella bicolor* (Hutton, 1834) (grey star), *Gastrocopta rupicola marginalba* (L. Pfeiffer, 1840) (yellow circle). **41.** *Streptartemon glaber* (L. Pfeiffer, 1849) (blue rectangle), *Gastrocopta servilis* (Gould, 1843) (red triangle).

Distribution: West Indies, Central America to Venezuela and Peru.

Habitat: Generally found in damp leaf litter and under rotting logs.

Remarks: The specimens collected obtain a maximum shell height of 15 mm. This species is particularly abundant in disturbed habitats, especially in agricultural areas.

Genus *Obeliscus* Beck, 1837

Subgenus *Stenogyra* Shuttleworth, 1854

***Obeliscus (Stenogyra) swiftianus* (L. Pfeiffer, 1853)**
(Figures 17, 34)

Opeas octogyrum plicatellum (Guppy [, 1868]).—Haas, 1962: 55; St. Christopher, Brimstone Hill.

Survey Material: Saint Kitts: St. George Basseterre Parish, road to Turtle Bay, south of Salt Pan (USDA); St. Thomas Middle Island Parish, lower slope of Brimstone Hill (USDA).

Distribution: Puerto Rico and northeastern Lesser Antilles.

Remarks: Haas (1962) misidentified this snail, using the name of a related species from Trinidad; we believe that his illustrated species is *Allopeas gracile*. This is the first confirmed record for Saint Kitts.

Genus *Subulina* Beck, 1837

***Subulina octona* (Bruguière, 1789)**
(Figures 18, 29, 34)

Subulina octona (Bruguière [, 1789]).—Haas, 1962: 49. St. Christopher, Winfield River; Brimstone Hill; Timothy Hill at Frigate Bay; Nevis, Jessops Village, Nelson's Spring, Jones' River.

Survey Material: **Saint Kitts:** St. George, Basseterre Parish, road to Turtle Bay, south of Salt Pan (USDA); St. John, Capisterre Parish, Saddler's Land Settlement, Lavington Ghut (USDA); St. Paul, Capisterre Parish, trailhead to Mount Liamuiga (AH); St. Thomas, Middle Island Parish, lower slope of Brimstone Hill (USDA); ibid., trail to D'Os Dane Pond, off Old Military trail (USDA); Trinity, Palmetto Point Parish, top of Ottley's Level (USDA); ibid., near base of Ottley's Level (USDA); **Nevis:** St. George, Gingerland Parish, along Source trail, N of Golden Rock Inn (AH); St. John, Figtree Parish, Saddle Hill (AH).

Distribution: Worldwide tropics and subtropics; in temperate zones in greenhouses.

Remarks: This widely distributed species, probably introduced centuries ago from Africa, is now one of the commonest species in the tropics and subtropics. It is considered to be an indicator of disturbed environments. The species is now recorded for the first time from Nevis.

Superfamily Streptaxoidea Gray, 1860

Family Streptaxidae Gray, 1860

Genus *Streptartemon* Kobelt, 1905

***Streptartemon glaber* (L. Pfeiffer, 1849)**
(Figures 28, 36, 41)

Material: **Saint Kitts:** St. George, Basseterre Parish, road to Turtle Bay, south of Salt Pan (USDA); St. John, Capisterre Parish, crater trail up Mount Liamuiga (USDA); St. Thomas, Middle Island Parish, lower slope of Brimstone Hill (USDA); ibid., near barracks and NW side of Brimstone Hill (AH); ibid., trail to D'Os Dane Pond, off Old Military trail (USDA); Trinity, Palmetto Point Parish, top of Ottley's Level (USDA); ibid., near base of Ottley's Level (USDA).

Distribution: Puerto Rico, U.S. Virgin Islands, Saint Thomas, Saint Croix, Saint Kitts, Dominica, Barbados, Venezuela, Guyana, Surinam, Brazil.

Remarks: This South American carnivorous species has been introduced throughout the Lesser Antilles by human activity. It appears to be very widespread on Saint Kitts; its effect on the native mollusks remains undocumented as yet.

Genus *Huttonella* L. Pfeiffer, 1856

***Huttonella bicolor* (Hutton, 1834)**
(Figures 35, 40)

Ennea (Huttonella) bicolor Hutton, 1834.—Tryon, 1885: 104; introduced to West Indies [no records for Saint Kitts and Nevis].

Survey Material: **Saint Kitts:** St. George, Basseterre Parish, Basseterre, La Guerite, Department of Agriculture (USDA).

Distribution: Africa; introduced into the tropics and subtropics worldwide, including USA (Florida), West Indies, Panama, Brazil.

Remarks: Specimens of this carnivorous species found on Saint Kitts have a shell height of up to 6.75 mm. The species might have been imported with potted plants. This is the first record for this island.

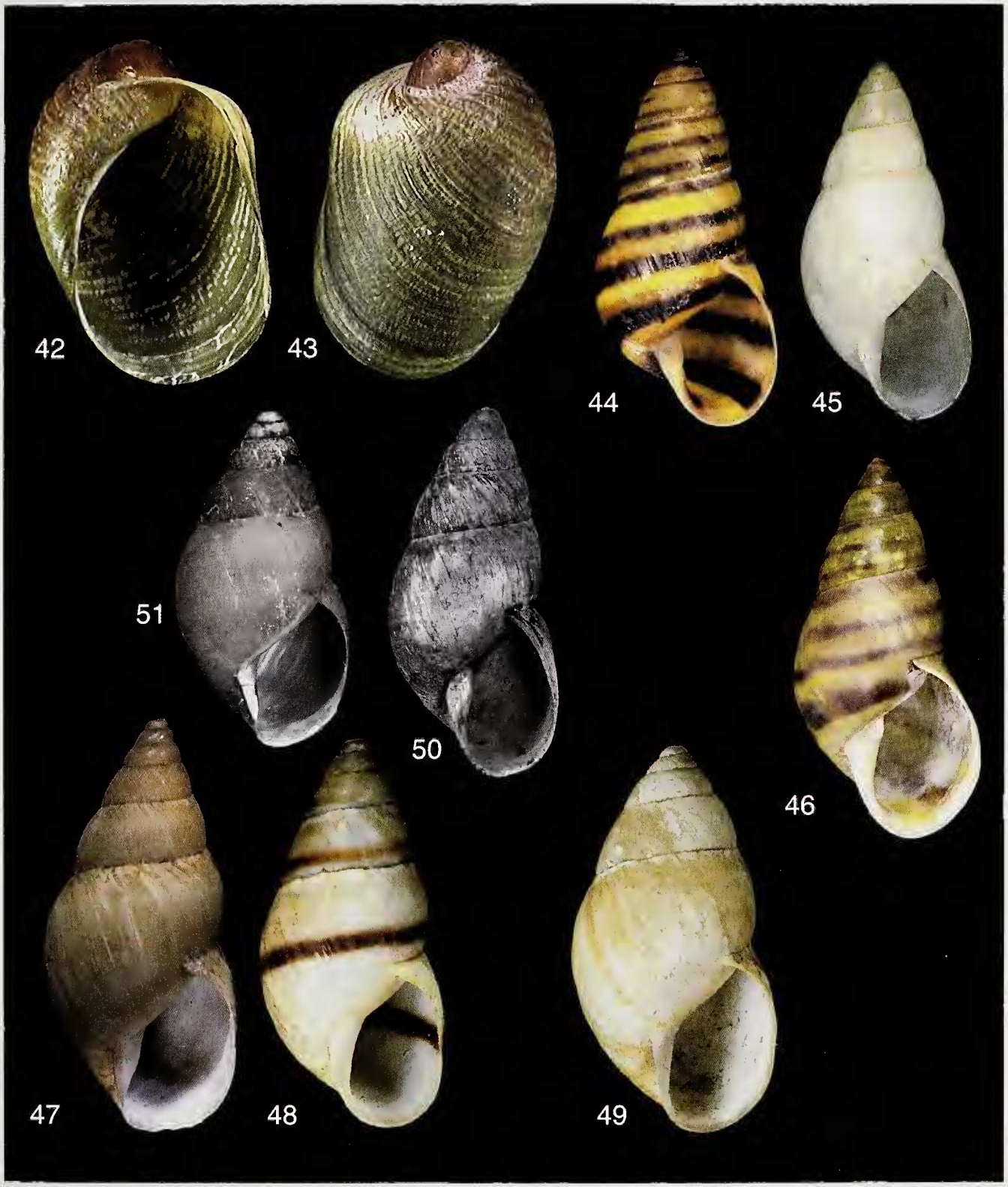
Superfamily Gastrodontoidea Tryon, 1866

Family Gastrodontidae Tryon, 1866

Genus *Zonitoides* Lehmann, 1862

***Zonitoides arboreus* (Say, 1817)**

Survey Material: **Saint Kitts:** Saint Thomas, Middle Island Parish, NW side of Brimstone Hill (AH).



Figures 42–51. Amphibulimidae and Bulimulidae species. **42–43.** *Amphibulima patula christopheri* Pilsbry, 1902, H = 17.3 mm. **44–45.** *Drymaeus (Antidrymaeus) multifasciatus christopheri* Pilsbry, 1899, H = 16.4 mm, respectively H = 14.6 mm. **46.** *Drymaeus (Antidrymaeus) multifasciatus* subspecies, H = 16.2 mm. **47.** *Bulimulus gittenbergeri* Breure, 1974, holotype RMNH 54903, H = 20.7. **48–49.** *Bulimulus guadalupensis* (Bruguière, 1789), H 17.6 mm, respectively H 17.4 mm. **50.** *Bulimulus ouallensis* Breure and Hovestadt new species, holotype RMNH 5003990, H = 19.0. **51.** *Bulimulus diaphanus fraterculus* (Potiez and Michaud, 1835), H = 16.5 mm.

Table 2. *Bulimulus ouallensis* Breure and Hovestadt new species. Measurements of the type material. Abbreviations: D, diameter; H, shell height; HA, height of aperture; LW, height of last whorl; P, number of protoconch whorls; W, total number of whorls; WA, width of aperture (all in mm). See also Breure (1974: figs 2–5).

	H	D	HA	WA	LW	W
Holotype	19	8.9	8.4	4.5	13	6.5
Paratype	20	8.5	8.8	5.5	14.3	6.5
Paratype	16.3	8.3	7.5	4.6	11.2	6
Paratype	19	9.4	6.8	4.8	10.9	6.3

Distribution: Widespread in North America, Bahamas, Puerto Rico.

Remarks: This is the first record for Saint Kitts of this widespread species, which is likely to have been introduced.

Superfamily Orthalicoidea Albers, 1860

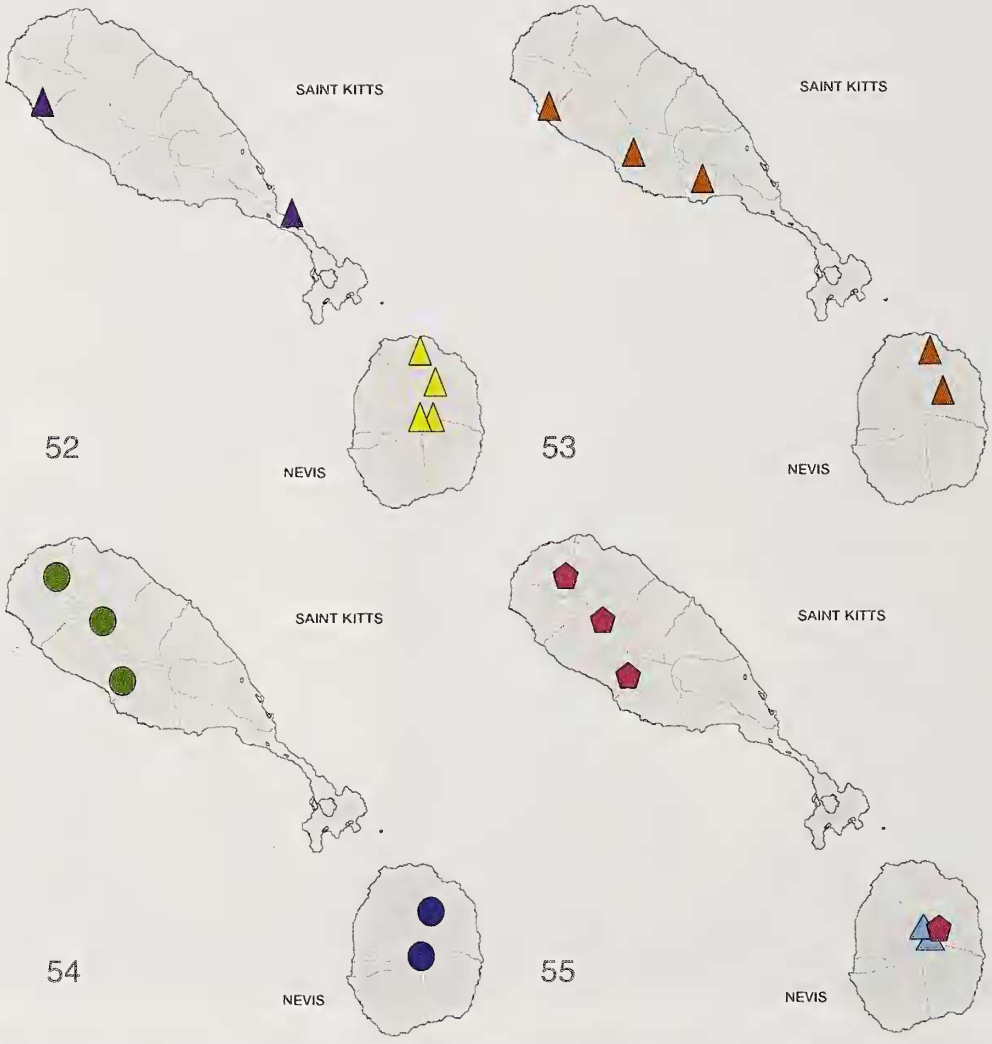
Family Bulimulidae Tryon, 1867

Genus *Bulimulus* Leach, 1814

Remarks: The species of this genus are usually difficult to differentiate, most of them being brownish and of similar shape. The accurate identification of several species from these islands can only be achieved through careful comparisons.

***Bulimulus diaphanus fraterculus* (Potiez and Michaud, 1835)**
(Figures 51–52)

Bulimus fraterculus 'F[érussac]' Potiez and Michaud, 1835.—Bland, 1862: 358; St. Kitts.



Figures 52–55. Distribution of Bulimulidae and Amphibulimidae. **52.** *Bulimulus gittenbergeri* Breure, 1974 (purple triangle), *B. diaphanus fraterculus* (Potiez and Michaud, 1835) (yellow triangle). **53.** *Bulimulus guadalupensis* (Bruguière, 1789) (orange triangle). **54.** *Drymaeus multifasciatus christopheri* Pilsbry, 1899 (green circle), *D. multifasciatus* subspecies (dark blue circle). **55.** *Bulimulus ouallensis* Breure and Hovestadt new species (light blue triangle), *Amphibulima patula christopheri* Pilsbry, 1902 (dark red polygon).

Bulimulus fraterculus Potiez and Michaud, 1835.—Pilsbry, 1897 [1897–1898]: 46, pl. 11 figs 24–25 (excluding Bland's record).

Bulimulus diaphanus fraterculus Potiez and Michaud, 1835.—Breure, 1974: 32, pl. 3 figs 6–10; pl. 7 fig. 1; reference to Bland's record.

Survey Material: **Nevis:** St. John, Windward Parish, cloud forest above Prison Farm (AH).

Distribution: Saint Martin, Saint Barts, Saba, Saint Eustatius, Nevis, Barbuda, Antigua, Guadeloupe, Les Saintes, Dominica.

Remarks: This taxon has been mentioned from Saint Kitts by Bland (1862), but no voucher material could be traced by Breure (1974). Pilsbry (1897 [1897–1898]: 46) wrote: "The *B. fraterculus* of American collections, reported from Porto Rico, St. Kitts, St. Croix, Antigua, St. John, St. Thomas, Trinidad and Barbados, is not this species; so the localities cited by Pfr. in Monogr. viii, p. 189, and by Smith, Ann. Mag. (6), viii, on the authority of Bland, do not refer to the true *fraterculus*". Breure (1974), after having found type material of Potiez and Michaud at the Muséum National d'Histoire Naturelle, Paris, confirmed the presence of this taxon only on the islands of Saint Martin, Saba, Saint Eustatius, Barbuda, and Guadeloupe. This is the first record for Nevis.

***Bulimulus guadalupensis* (Bruguière, 1789)**
(Figures 48–49, 53)

Bulimus exilis Gm[elin], 1791.—Bland, 1862: 358; St. Kitts.

Bulimulus exiles [sic] Gmelin, 1791.—Rush, 1891: 69.

Bulimulus exilis Gmelin, 1791: Pilsbry, 1897 [1897–1898]: 37, pl. 9 figs 61–67; St. Christopher or St. Kitts.

Bulimulus (Bulimulus) guadalupensis (Bruguière, 1789).—Breure, 1974: 15, figs 6–60, pl. 2.; St. Kitts, Timothy Hill at Frigate Bay; Frigate Bay beach; between Jugate Bay and Basseterre; Phillips. Nevis.

Survey Material: **Saint Kitts:** St. George, Basseterre Parish, Basseterre, La Guerite, Department of Agriculture (USDA); St. Thomas, Middle Island Parish, lower slope of Brimstone Hill (USDA); Trinity, Palmetto Point Parish, top of Ottley's Level (USDA); ibid., near base of Ottley's Level (USDA); **Nevis:** St. James, Windward Parish, above Prison Farm (USDA); ibid., Camp's River (USDA).

Additional Material Examined: **Saint Kitts:** T. Bland leg., ex A.D. Brown (ANSP 3519); Dietz leg., ex Swift coll. (ANSP 25574); C.A. Barber leg., ex T.D.A. Cockerell (ANSP 78301).

Distribution: Probably originated in the Windward Islands (Breure, 1974); now distributed throughout the Caribbean Basin, including Florida.

***Bulimulus gittenbergeri* Breure, 1974**
(Figures 47, 52)

Bulimulus gittenbergeri Breure, 1974.—27, pl. 5 figs 10–13; pl. 7 figs 3: St. Kitts, limestone NW Brimstone Hill.

Survey Material: **Saint Kitts:** St. George, Basseterre Parish, road south of Basseterre (USDA); St. Thomas, Middle Island Parish, lower slope of Brimstone Hill (USDA); ibid., Brimstone Hill (AH).

Additional Material Examined: **Saint Kitts:** NW Brimstone Hill (RMNH 54903, holotype), RMNH 54904, FMNH 174171, SMF 225900 (paratypes); top of Brimstone Hill (RMNH), Wingfield River (RMNH).

Distribution: Endemic to Saint Kitts.

Habitat: Occurring in arid scrub forests of the coastal zone, where it was collected among shrubs.

Remarks: The specimens collected have a shell height up to 20.5 mm.

***Bulimulus ouallensis* Breure and Hovestadt new species**
(Figures 50, 55)

Diagnosis: A species of *Bulimulus* up to 20.0 mm, with slightly convex sides and a rather thin shell, sculptured with spiral striation on the epidermis, protoconch pit-reticulated in its latter half.

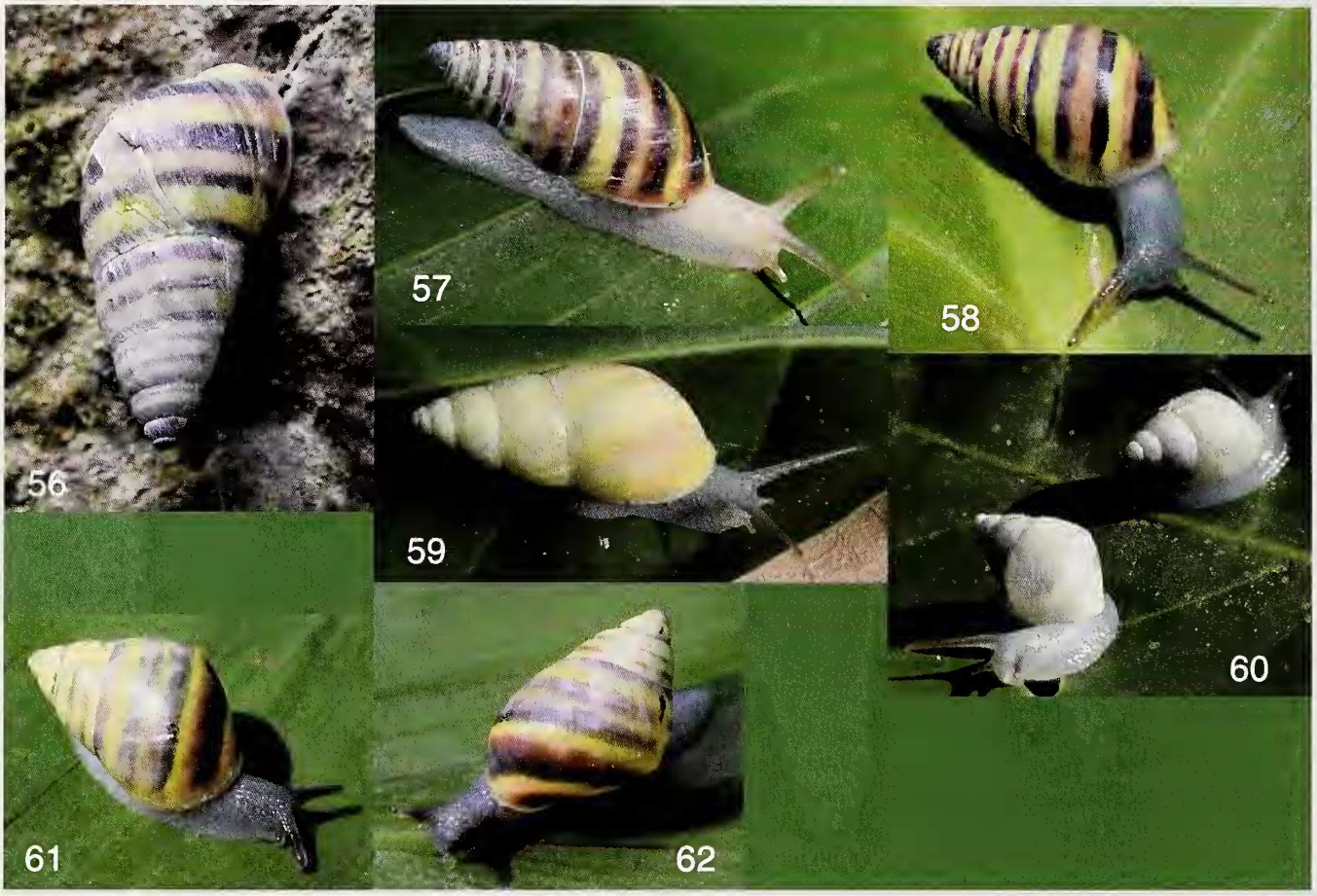
Description: Shell up to 20.0 mm, 2.1 times as long as wide; narrowly perforated, acute with slightly convex sides; rather thin. Colour light brown when epidermis present, apex purplish-brown. Surface opaque, epidermis usually with very delicate spiral striae; teleoconch sculptured with incrassate growth striae, approximately 1 mm apart; striae fuse into white tufts, giving the impression of a narrow white band running just below suture. Protoconch marked with oblique riblets running at an angle of 45 degrees with regard to body axis, for first whorl. Following half- whorl shows also riblets at an angle of 115 degrees, making the surface pit-reticulated. Whorls 6.5, slightly convex; ultimate whorl about 0.66 total height. Suture deepened. Aperture 0.42 shell height, 1.6 times as long as wide; subovate, whitish inside; apertural deviation five degrees. Peristome thin; columellar margin slightly reflexed and dilated above.

Dimensions of holotype: shell height 19.0, diameter 8.9, height of aperture 8.4, width of aperture 4.5, height of last whorl 13.0; 6.5 whorls.

Type Material: **Holotype:** RMNH 5003990, A. Hovestadt leg., 17 November 2014, from type locality; **Paratypes:** three shells, St. John Windward Parish, above Prison Farm.

Type Locality: Nevis, St. George, Gingerland Parish, along Source trail, North Golden Rock Inn.

Distribution: Endemic to Nevis.



Figures 56–62. Living snails of the family Bulimulidae. **56–60.** *Drymaeus (Antidrymaeus) multifasciatus christopheri* Pilsbry, 1899; **61–62.** *Drymaeus (Antidrymaeus) multifasciatus* subspecies.

Habitat: Living specimens have been observed crawling on the ground among fallen leaves and climbing on tree trunks, in the wet rainforest.

Remarks: *Bulimulus ouallensis* may be compared to the neighboring species from Saint Kitts, *Bulimulus gittenbergeri* Breure, 1974, from which the new taxon differs by (1) having the sides slightly convex; (2) the light brown color. This new species may also be compared to *Bulimulus lehmanni* (L. Pfeiffer, 1865), occurring on Dog Island, Anguilla and Saint Martin-Sint Maarten, but the latter species has definitely coarser growth striae, lacks the pit-reticulated surface of the protoconch and lacks the sutural tufts; the shell is also more solid. The key to Caribbean *Bulimulus* species (Breure, 1974: 11–12) may be adapted as follows:

13a. Sides straight 14
13b. Sides slightly convex . . . . . *B. ouallensis*
14a. Colour yellowish to greyish white; aperture white inside . . . . . *B. gittenbergeri*
14b. Colour pale russetbrown; inside aperture coloured like outside . . . . . *B. fuscus*

Etymology: The specific epithet derives from *Oualla*, the pre-Colombian name for the island, meaning "land of the beautiful waters", which presumably refers to the many water sources and the hot volcanic springs on the island.

Genus *Drymaeus* Albers, 1850

Subgenus *Antidrymaeus* L. Germain, 1907

Remarks: In a forthcoming paper, Breure and Robinson will show that several *Drymaeus* species from the Caribbean Basin form a monophyletic group, for which the name *Antidrymaeus* L. Germain, 1907 may be used. The common characteristic in the external morphology of this group is the bluish color of the body, most noticeable in juvenile specimens.

***Drymaeus (Antidrymaeus) multifasciatus christopheri* Pilsbry, 1899 new combination**
(Figures 54, 56–60)

Bulimus multifasciatus Lam[arck], 1822.—Bland, 1862: 358. St. Kitts.
Bulimulus multifasciatus Lamarck, 1822.—Rush, 1891: 69. St. Kitts.
Drymaeus multifasciatus var. *christopheri* Pilsbry, 1899.—16, pl. 13 figs 98–99. St. Christopher.

Drymaeus multifasciatus christopheri Pilsbry, 1899.—Clench and Turner, 1962: 31.
Drymaeus multifasciatus christopheri Pilsbry, 1899.—H.B. Baker, 1963: 227 (lectotype designation).

Survey Material: **Saint Kitts:** Christchurch, Nichola Town Parish, trail to Phillips Level (USDA); St. Paul, Capisterre Parish, crater trail up Mount Liamuiga (USDA); Trinity, Palmetto Point Parish, trail to Ottley's Level (AH).

Additional Material Examined: **Saint Kitts:** ex Swift coll. (ANSP 25857, lectotype), (ANSP 325063, paralectotypes); T. Bland, ex A.D. Brown (ANSP 3417); (UF 176958).

Distribution: Endemic to Saint Kitts.

Habitat: Occurs in rainforest.

***Drymaeus (Antidrymaeus) multifasciatus* subspecies**
(Figures 54, 61–62)

Survey Material: **Nevis:** St. George, Gingerland Parish, Herbert Heights, trail up Nevis peak past Rawlin's Entrance, D.G. Robinson leg., 17 March 2004 (USDA); ibid., near Peak Heaven (AH*); St. James, Windward Parish, above Prison Farm, D.G. Robinson leg, 12 March 2004 (USDA); ibid. (AH*).

Distribution: Endemic to Nevis.

Habitat: Occurring in cloud forest and rain forest.

Remarks: This subspecies differs from the previous subspecies by the far less brightly-colored adult shell, instead showing dull bands of reddish-brown and yellow, which have a tendency to fade away into the background color; the patch around the umbilicus is also less colored than the material from Saint Kitts.

Family Amphibulimidae P. Fischer, 1873

Genus *Amphibulima* Lamarck, 1805

***Amphibulima patula christopheri* Pilsbry, 1902**
(Figures 42–43)

Succinea patula Brug[uière], 1789.—Bland, 1862: 358. St. Kitts.
Amphibulima patula Bruguière, 1789.—Rush, 1891: 69.
Amphibulima patula Bruguière, 1789.—Pilsbry, 1899: 234, pl. 61 figs 14–19. St. Kitts, Bayford Estate.
Amphibulima patula var. *christopheri* Pilsbry, 1902.—lxviii, pl. 60 figs 11–12; pl. 62, figs 27–30. St. Kitts.
Amphibulima patula christopheri Pilsbry, 1902.—Clench and Turner, 1962: 31.
Amphibulima patula christopheri Pilsbry, 1902.—H.B. Baker, 1963: 227 (lectotype designation).
Amphibulima patula christopheri Pilsbry, 1902.—Breure, 1973: 53.

Survey Material: **Saint Kitts:** St. John Capisterre Parish, crater trail up Mount Liamuiga (USDA); St. Thomas Middle Island Parish, trail to D'Os Dane Pond, off Old Military trail (USDA); Trinity Palmetto Point Parish, top of Ottley's Level (USDA); **Nevis:** St. James Windward Parish, above Prison Farm (USDA).

Distribution: Saint Kitts, Nevis.

Habitat: This semi-slug seems to be restricted to rain and cloud forests.

Remarks: This is the first report for this taxon from Nevis. Another subspecies, from Dominica, has been reported to frequent banana and *Citrus* trees (Robinson et al., 2009: 638).

Superfamily Pupilloidea Turton, 1831

Family Gastrocoptidae Pilsbry, 1918

Genus *Gastrocopta* Wollaston, 1878

***Gastrocopta barbadensis* (L. Pfeiffer, 1854)**

Gastrocopta (Gastrocopta) barbadensis barbadensis (L. Pfeiffer [, 1854]).—Haas 1960: 6, pl. 2 figs A–F. St. Christopher, Brimstone Hill. Nevis, Jessops Village; Jones' River.

Survey Material: Not collected during these surveys.

Additional Material Examined: **Saint Kitts:** Brimstone Hill (RMNH). **Nevis:** Jessops Village (RMNH); Jones' River (RMNH).

Distribution: West Indies.

***Gastrocopta rupicola marginalba* (L. Pfeiffer, 1840)**
(Figures 11, 40)

Gastrocopta (Gastrocopta) rupicola marginalba (L. Pfeiffer[, 1840]).—Haas 1960: 12, pl. 2, fig. K; pl. 5 figs A–D. St. Christopher, Timothy Hill; Frigate Bay; Brimstone Hill.

Survey Material: **Saint Kitts:** St. Thomas, Middle Island Parish, base of Brimstone Hill (USDA).

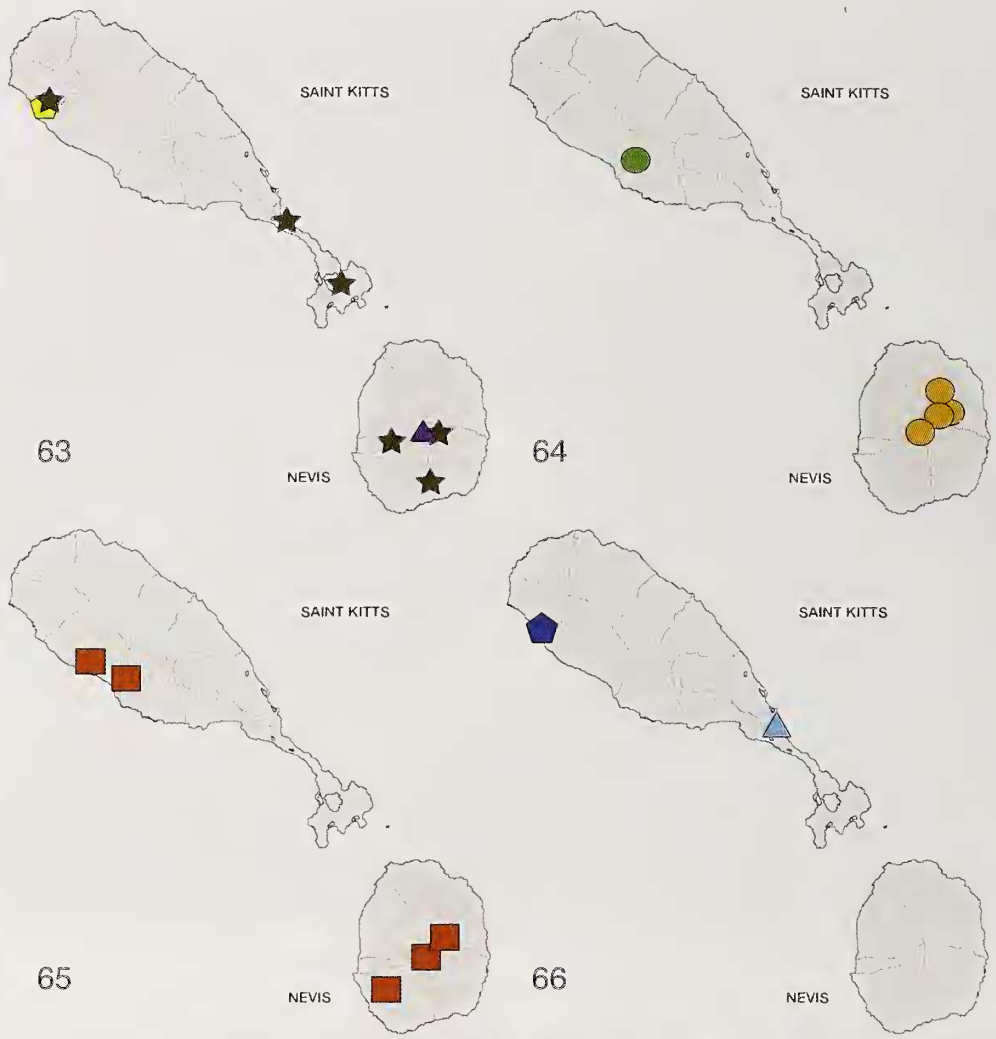
Distribution. Saint Thomas, Saint Croix, Dog Island, Saint Martin, Saint Kitts, southern United States and northern Mexico.

***Gastrocopta servilis* (Gould, 1843)**
(Figures 12, 41)

Gastrocopta (Gastrocopta) servilis servilis (Gould [, 1843]).—Haas, 1960: 11, pl. 4 figs F–H. St. Christopher, Morne Hills.

Survey Material: **Saint Kitts:** St. George Basseterre Parish, road to Turtle Beach, south of Salt Pan (USDA); St. Thomas Middle Island Parish, base of Brimstone Hill (USDA).

Distribution: West Indies, Central America, Venezuela.



Figures 63–66. Distribution Pupillidae, Sagdidae, Philomycidae, Gastrodontidae, Polygyridae and Pleurodontidae species. **63.** *Pupoides marginatus nitidus* (L. Pfeiffer, 1839) (yellow polygon), *Hojeda* sp. (brown star), *Pallifera* sp. (purple triangle). **64.** *Pleurodonte guadeloupensis* ssp. (green circle), *P. josephinae nevisensis* (Pilsbry, 1889) (orange circle). **65.** *Zachrysia provisoria* (L. Pfeiffer, 1858) (red rectangle). **66.** *Polygyra p. plana* (Dunker in Philippi, 1843) (light blue triangle), *Zonitoides arboreus* (Say, 1817) (dark blue polygon).

Family Pupillidae Turton, 1831

Genus *Pupoides* L. Pfeiffer, 1854

***Pupoides marginatus nitidulus* (L. Pfeiffer, 1839)**
(Figures 13, 63)

Pupoides (*Pupoides*) *marginatus nitidulus* (L. Pfeiffer [, 1839]).—Haas, 1960: 5, pl. 1 Figure D. St. Christopher, Brimstone Hill; Nevis, Mosquito Bay.

Survey Material: **Saint Kitts:** St. Thomas, Middle Island Parish, base of Brimstone Hill (USDA).

Distribution: West Indies.

Superfamily Sagdoidea Pilsbry, 1895

Family Sagdidae Pilsbry, 1895

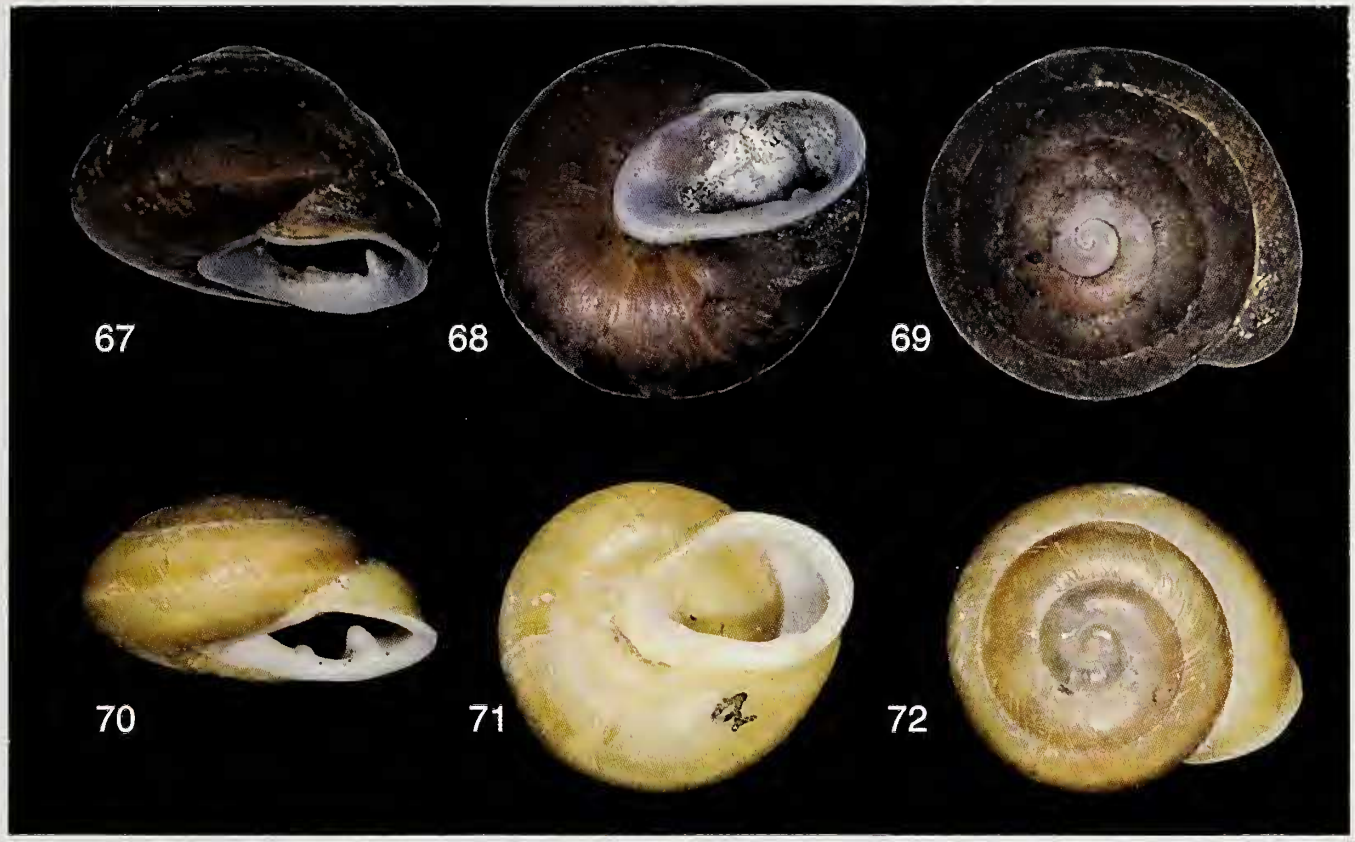
Genus *Hojeda* H.B. Baker, 1926

***Hojeda* species**
(Figures 37–39)

Survey Material: **Saint Kitts:** St. George, Basseterre Parish, road to Turtle Beach, south of Salt Pan (USDA); ibid., road south of Basseterre (USDA); St. Thomas, Middle Island Parish, lower slope of Brimstone Hill (USDA); **Nevis:** St. George, Gingerland Parish, Montravers Estate (AH); St. John, Figtree Parish, Saddle Hill (AH); St. Paul, Charlestown Parish, Hamilton Estate ruins (AH).

Distribution: Guadeloupe, Saint Kitts, Nevis, Saint Eustatius.

Habitat: Found in xerophytic environments on Saint Kitts.



Figures 67–72. Pleurodontidae species. **67–69.** *Pleurodonte guadeloupensis* subspecies, D 14.1 mm. **70–72.** *Pleurodonte josephinae nevisensis* (Pilsbry, 1889), lectotype ANSP 32590, D 17.7 mm.

Remarks: This small sagid (up to 4.5 mm in diameter) closely resembles the Cuban *Hojeda boothiana* (L. Pfeiffer, 1839), but differs by its lower spire, which gives a flatter appearance to the shell. *Hojeda vannattai* H.B. Baker, 1924 from Aruba, and Margarita Island (off the Venezuelan coast) is also very similar but has consistently a somewhat larger umbilicus. Specimens from Saint Eustatius, collected during the late 18th century (ANSP 28312), are virtually identical; similar shells have also been found on Guadeloupe (Robinson, unpublished data).

Superfamily Helicoidea Rafinesque, 1815

Family Polygyridae Pilsbry, 1895

Genus *Polygyra* Say, 1818

***Polygyra plana plana* (Dunker in Philippi, 1843)**
(Figure 66)

Survey Material: **Saint Kitts:** Gardens of the Sugar Bay Club, near North Frigate Bay (AH).

Distribution: Bermuda, Saint Kitts.

Habitat: This is an introduced species, occurring in well-watered gardens.

Remarks: This is the first record for this taxon from Saint Kitts and Nevis. The nominal subspecies occurs on Bermuda. Another subspecies, *Polygyra plana bahamensis* Vanatta, 1919, can be found in the Bahamas and the Turks and Caicos Islands.

Superfamily Arionoidea Gray, 1840

Family Philomycidae Gray, 1847

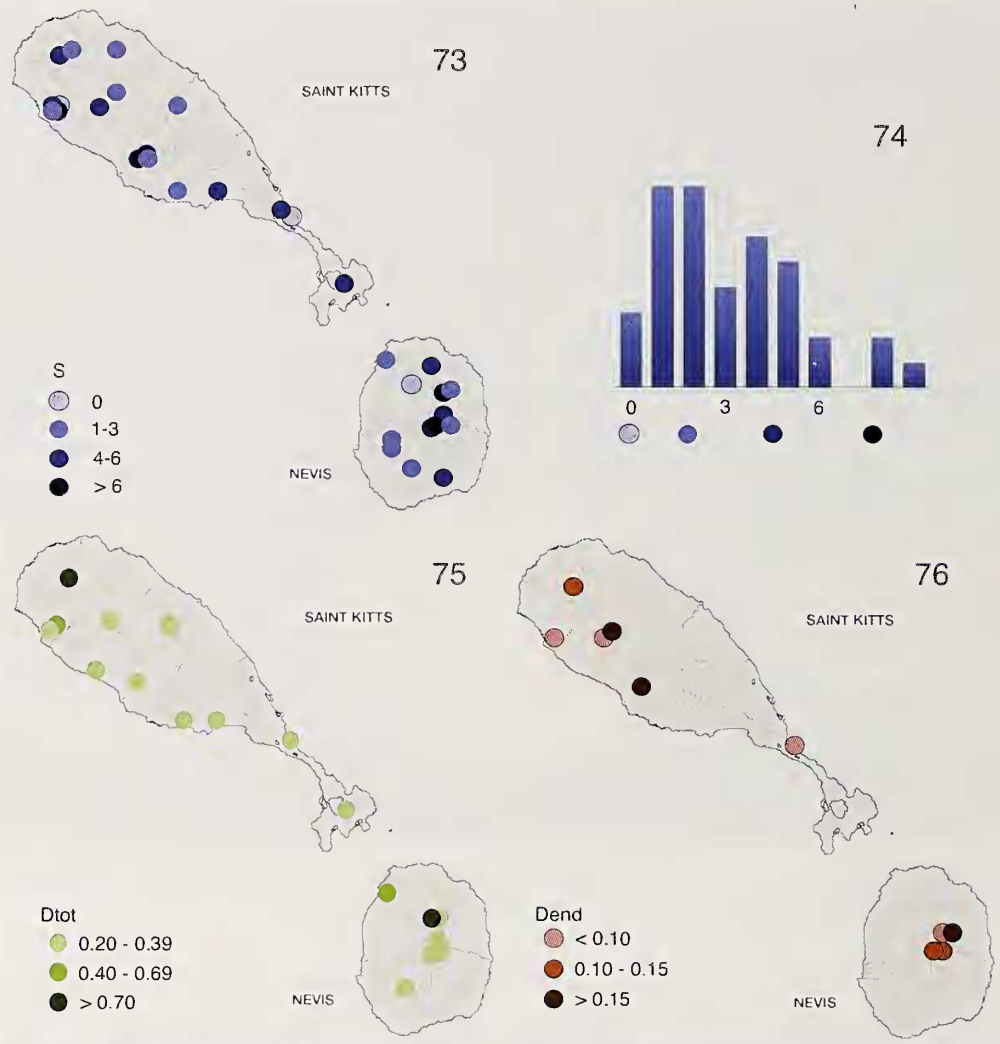
Genus *Pallifera* Morse, 1864

***Pallifera* species**
(Figure 24)

Survey Material: **Nevis:** St. George, Gingerland Parish, Herbert Heights, trail to Nevis Peak (USDA).

Distribution: Nevis; USA.

Remarks: This species has been reported from Montserrat (Shoobs and Coote, 2014, as *Pallifera dorsalis* (Binney, 1842)) and Martinique and Guadeloupe (Delannoye et al., 2015, as *P.* spec.). This is the first record for Saint Kitts and Nevis. It is most likely introduced from elsewhere; until its identity can be ascertained, it is not possible to determine its origin at present.



Figures 73–76. Diversity of land snails on Saint Kitts and Nevis. **73.** Species richness per locality. **74.** Frequency of species richness. **75.** Total diversity; calculated using rareness (see methods), only localities scoring 0.20 or higher shown. **76.** Diversity of endemic species (see methods).

Superfamily Helicoidea Rafinesque, 1815

Family Pleurodontidae von Ihering, 1912

Genus *Pleurodonte* Fischer von Waldheim, 1807

***Pleurodonte guadeloupensis* subspecies**
(Figures 64, 67–69)

Survey Material: **Saint Kitts:** Trinity Palmetto Point Parish, top of Ottley's Level (USDA); ibid., trail to Ottley's Level (AH).

Distribution: Saint Kitts.

Remarks: This snail belongs to the *Pleurodonte guadeloupensis* species complex of Guadeloupe, Dominica, Saint Martin, and Martinique. It differs from the other subspecies in this complex in being higher-spired, with slightly different labial dentition.

***Pleurodonte josephinae nevisensis* (Pilsbry, 1889)**
(Figures 30, 64, 70–72)

Helix josephinae Fér[ussac], 1832.—Bland 1862: 358; St. Christopher.
Helix (Dentellaria) josephinae Férussac, 1832.—Pilsbry 1889: 88, pl. 29 figs 31–33; Various islands, including subfossils from St. Kitts and Nevis.
Helix josephinae var. *nevisensis* Pilsbry 1889.—89, pl. 25 figs 54–55; Nevis.
Helix (Dentellaria) josephinae nevisensis Pilsbry, 1899.—Clench and Tuner 1962: 104 ["no locality given"; sic].
Helix josephinae nevisensis Pilsbry, 1899.—H.B. Baker, 1963: 246.

Survey Material: **Nevis:** St. George, Gingerland Parish, Herbert Heights, trail to Nevis Peak (USDA); ibid., near Peak Heaven (AH); ibid., along Source trail, N Golden Rock Inn (AH); St. James, Windward Parish, above Prison Farm (AH, USDA).

Figure 77. Land cover and forest formations on Saint Kitts and Nevis, 1999–2003, with distribution of endemic species. Modified after Helmer et al. 2006; grid lines refer to the UTM system. Triangles refer to the localities where endemic species were found (light color, one species; dark colored, two species). Enlarged parts of the islands indicated with corresponding colors. Scale = 4 km.

Additional Material Examined: **Saint Kitts:** T. Bland leg., ex A.D. Brown (ANSP 1052, subfossil); ex Swift coll. (ANSP 32591, subfossil); J.S. Phillips leg. (ANSP 30907; see remarks); **Nevis:** T. Bland leg. (ANSP 32590, syntype); A.D. Brown leg. (ANSP 110428).

Distribution: Saint Kitts?, Nevis.

Habitat: This species exhibits a marked preference for humid conditions in dense vegetation, being particularly abundant on the upper slopes of Nevis Peak.

Remarks: The more widespread *Pleurodonte josephinae* (Férussac), occurring on Guadeloupe, and Dominica, has been reported to occur on both Saint Kitts and Nevis, based on subfossil specimens. However, Pilsbry (1889) recognized the population still living on Nevis as a distinct subspecies; he may have been unaware that the subfossils also belong to this taxon. Two specimens (ANSP 30907) were collected early 20th century on Saint Kitts. One, a fully developed adult, appears to have a higher spire than any of the Nevisian material we have seen. These shells may represent a surviving Kittitian population that we were unable to locate.

Genus *Zachrysia* Pilsbry, 1894

***Zachrysia provisoria* (L. Pfeiffer, 1858)**
(Figure 65)

Survey Material: **Saint Kitts:** St. Thomas, Middleland Parish, near Romney Manor (AH); Trinity Palmetto Point Parish, Ottley's Plantation House (AH); **Nevis:** St. George, Gingerland Parish, near Peak Heaven (AH); ibid., Montravers Estate (AH*); St. John, Figtree Parish, Prospect, Experimental Station (USDA).

Distribution: Cuba; introduced to Florida, the Bahamas Islands, Cayman Islands, Jamaica, Saint Thomas, Saint Croix, Antigua, Anguilla, Saint Martin-Sint Maarten, Saint Barts, Nevis, Guadeloupe, Barbados, Mustique, Curaçao.

Remarks: This potentially serious horticultural pest appeared to be restricted to a single greenhouse in Nevis at the time of collection (2004). However, during the past decade the species has spread and has now been found at disturbed environments on both islands. It was recently reported as introduced on Guadeloupe (Massemin and Pointier, 2010).

Species Doubtfully or Erroneously Reported From the Islands

Due to inaccuracies in provenance of snail specimens (or the total lack of locality data) collected during the 18th and early 19th century, or misidentifications by later authors, the following species have been reported from Saint Kitts. As there is no supporting evidence that these species are actually occurring on one or both islands, these taxa should be removed from the list of terrestrial mollusks from Saint Kitts and Nevis.

***Helicina (Analcadia) antillarum* G.B. Sowerby II, 1842**

Helicina antillarum G.B. Sowerby II, 1842.—Rush, 1891: 67; St. Kitts.

Remarks: This species is distributed on Guadeloupe (but see, Dominica, and Martinique. The record by Rush is likely based on a misidentification. Delannoye et al., 2015, however, indicated that the species is most likely endemic to Martinique). It should be noted that Rush (1891) also reported an unidentified *Helicina* species. We did not encounter any helieinid other than the two reported herein.

***Glyphyalina barbadensis* Chase and Robinson, 2001**

Hyalina incisa L. Pfeiffer, 1866.—Rush 1891: 68; St. Kitts.

Remarks: This taxon was described from Barbados as *Hyalina incisa* by Pfeiffer (1866), and subsequently renamed *Glyphyalina barbadensis* by Chase and Robinson (2001), the original name being unavailable. We did not encounter this zonitoid species during the surveys. It may be that Rush misidentified either immature specimens of *Streptaxis glaber* (Pfeiffer) or the *Hojeda* species mentioned above, whose shells are superficially similar.

***Drymaeus (Mesembrinus) virgulatus* (Férussac, 1821)**

Drymaeus (Mesembrinus) liliaceus Férussac, 1832.—Pilsbry 1889: 11; St. Kitts?

Remarks: Pilsbry reported this taxon from Saint Kitts without giving a reference. We have been unable to trace any specimens collected from the island.

DISCUSSION

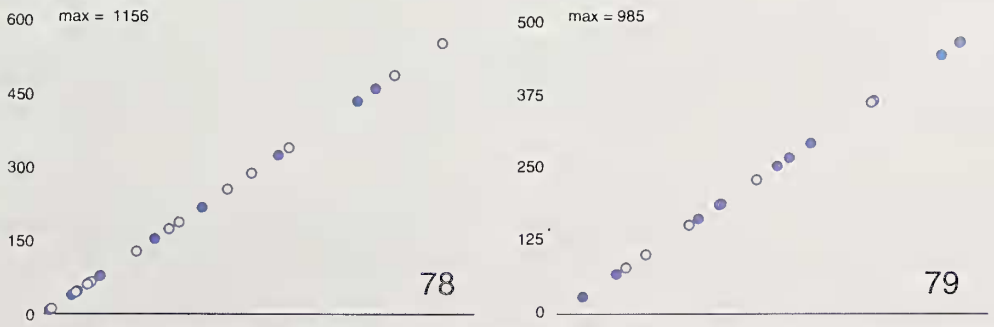
Our list of land Mollusca from Saint Kitts and Nevis (Table 3) contains at present 33 taxa, of which six (18%) are confined to one island (single island endemics; SIEs); one taxon is endemic to both islands. Two species have been found which are likely introduced, but at present their systematic position cannot be ascertained. Of the list, 22 species are widespread in the West Indies or beyond (66%). During geological times the areas of these islands have been dynamic and at the height of the Late Glacial Maximum (26,500 to 19,000 years before present) sea levels were ca. 150 m lower (Clark et al., 2009). During this time, Saint Kitts and Nevis were united with Saint Eustatius on the "paleo-island" Saint Kitts-Nevis Bank. This paleo-island, like others in the Lesser Antilles at that time, may have well served as separate biogeographic areas (Peck, 2011). When we take the land snails of Saint Eustatius into account (Hovestadt, 1980), eight taxa (24%) are endemic to this paleo-island; 11 taxa (33%) may be called Lesser Antillean endemics.

We have furthermore analyzed the fauna with respect to altitudinal occurrence, and whether they occur on the

Table 3. Summary of species, alphabetically arranged, and their distribution. Abbreviations: E, endemic; I, introduced; ×, collected during surveys mentioned in this paper (Saint Kitts and Nevis) or known from literature (other islands);?, questionable reports. Species reported for Saints Kitts and Nevis for the first time are shown in bold type.

Taxon	St. Kitts	Nevis	St. Eustatius	Lesser Antilles, other	Other
Allopeas gracile	X	X	X	X	X
Allopeas micra	X	X	X	X	X
Amphibulima patula christopheri	X	X			
Beckianum beckianum	X	X	X	X	X
Bulimulus diaphanus fraterculus		X	X	X	
Bulimulus gittenbergeri	E				
Bulimulus guadalupensis	X	X	X	X	X
Bulimulus ouallensis		E			
Diplosolenodes sp.		X / I?			
Drymaeus multifasciatus christopheri	E				
Drymaeus multifasciatus subspecies		E			
Gastrocopta barbadensis	X		X	X	X
Gastrocopta rupicola marginata	X	X		X	X
Gastrocopta servilis	X		X	X	X
Helicina fasciata	X	X	X	X	
Hojeda sp.	X	X	X	X	
Huttonella bicolor	I			I	X
Leptinaria unilamellata	X	X		X	X
Lucidella plicatula christophori	X	X			
Obeliscus swiftianus	X			X	X
Pallifera sp.		X / I?			I
Pleurodonte guadeloupensis ssp.	E				
Pleurodonte josephinae nevisensis		E			
Polygyra plana plana	X				X
Pupoides marginatus nitidulus	X		X	X	X
Streptartemon glaber	X	X		X	X
Subulina octona	X	X	X	X	X
Succinea sp. A	X				
Succinea sp. B		X			
Veronicella aff. floridana	X	X		X	X
Veronicella cubensis	X	X		X	X
Zachrysia provisoria	I	I		I	X
Zonitoides arboreus	I		X	X/I?	X

windward (northeast) or leeward (southwest) side of the islands. Although the highest elevations have not been well-sampled (Figures 78–79), some observations may be made. A number of species occur only at lower altitudes, viz. *Succinea* species, *Obeliscus swiftianus*, *Zonitoides arboreus*, *Huttonella bicolor*, *Bulimulus gittenbergeri*, *Gastrocopta* species, *Pupoides marginatus nitidulus*, *Polygyra plana plana*, and *Zachrysia provisoria*. With the exception of *Bulimulus gittenbergeri*, these species are largely introduced species. In contrast, a few species seem to be restricted to higher elevations, i.e. above 250 m: *Diplosolenodes* species, *Drymaeus* species, *Amphibulima patula christopheri*, and *Pleurodonte josephinae nevisensis* (Figures 80–81).



Figures 78–79. Altitudinal range of localities sampled. **78.** Saint Kitts. **79.** Nevis. Dark circles indicate localities at windward side of the island.

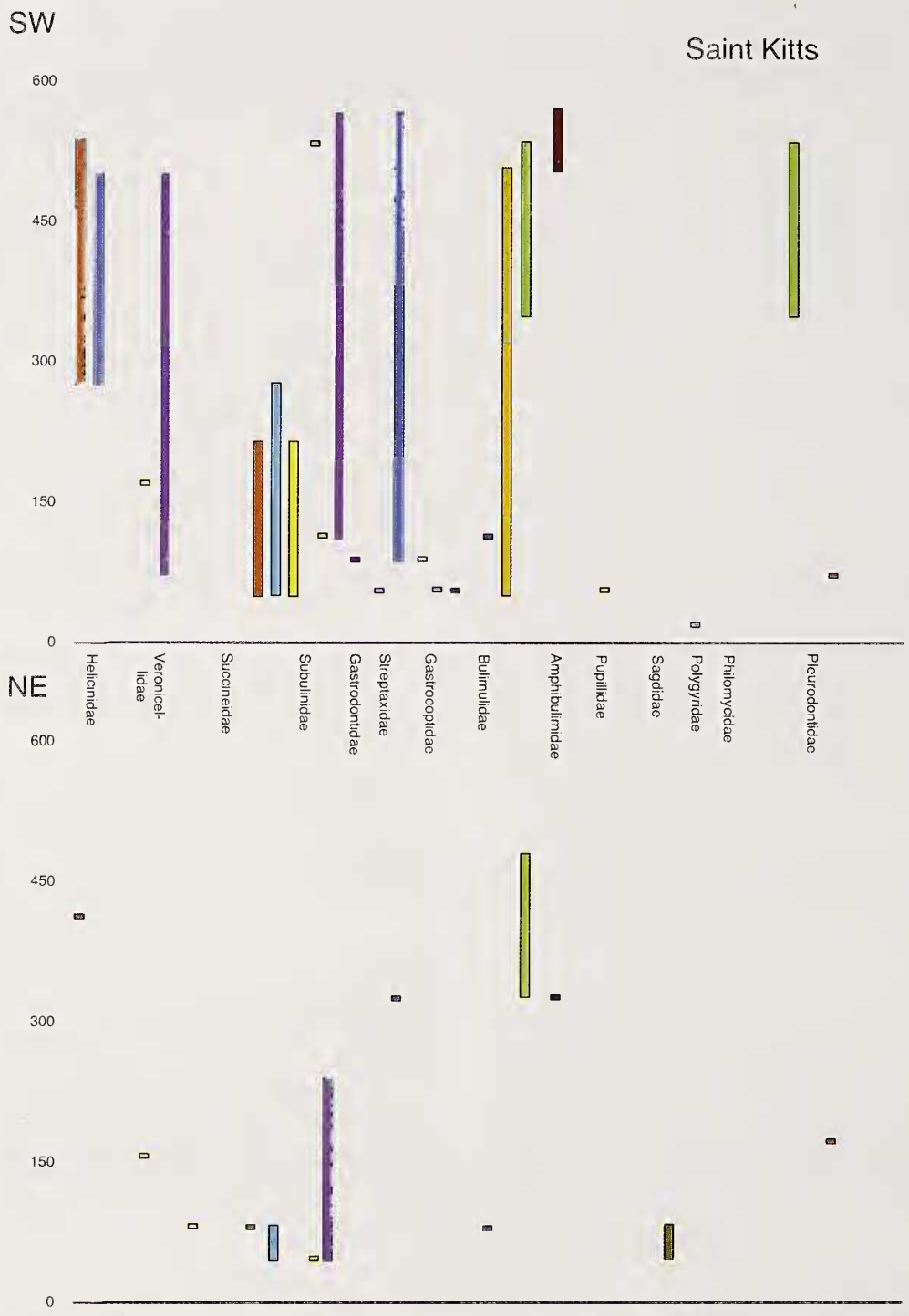


Figure 80. Altitudinal range of species on Saint Kitts, respectively on leeward (upper) and windward (lower) sides of the island. Colours correspond to those used in distribution maps.

When analyzing the localities related to their diversity (see Methods), it is clear that most of them have a rather low species diversity. At four localities no snails were found; at the remaining localities species diversity ranged from 1 to 9 (mean 3.12; Figure 73). Taking the rareness of species into account, the higher elevational localities tend to score higher (Figures 75–76). There are six species endemic to both islands (of which five are SIEs): *Bulimulus gittenbergeri*, *B. ouallensis*, *Drymaeus* (*Antidrymaeus*) *multifasciatus christopheri*, *D.* (*A.*) *m.* subspecies (Nevis), *Amphibulima patula christopheri*, and *Pleurodonte josephinae nevisensis*. The localitions where these endemics have been found are given in Figure 77. The data (adapted from Helmer et al., 2006)

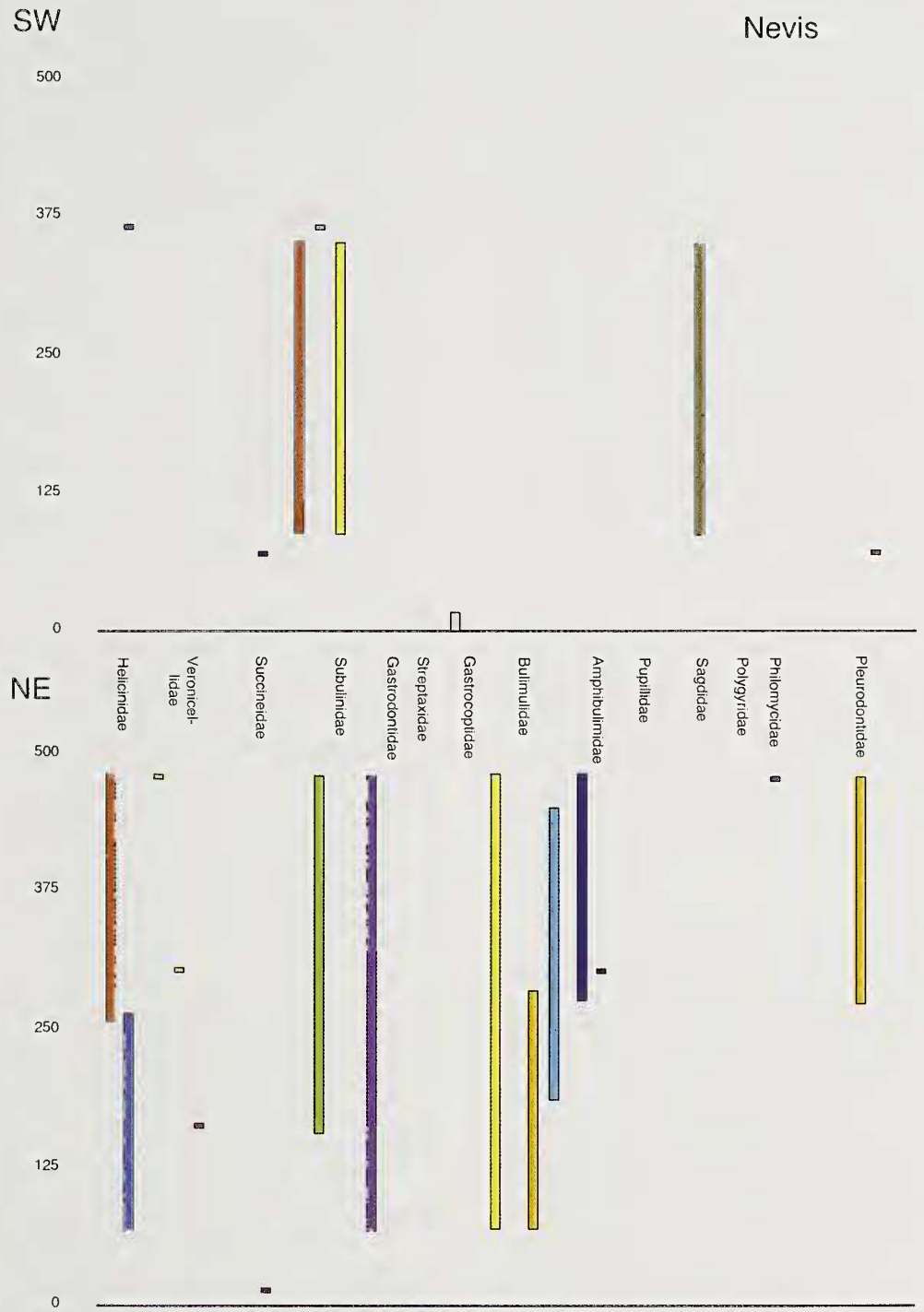


Figure 81. Altitudinal range of species on Nevis, respectively on leeward (upper) and windward (lower) sides of the island. Colours correspond to those used in distribution maps.

show that these endemics occur in five vegetation types, of which three are drought and two are wet types: Drought Deciduous Open Woodland (*Bulimulus gittenbergeri*), Drought Deciduous Coastal Shrubland (*B. gittenbergeri*), Drought Semi-Deciduous Forest (*Drymaeus* (*Antidrymaeus*) *multifasciatus christopheri*), Seasonal Evergreen Forest (*D.* (*A.*) *multifasciatus christopheri*, *D.* (*A.*) *m.* subspecies (Nevis), *Amphibulima patula christopheri*, *Pleurodonte josephinae nevisensis*), and Evergreen Forest (*B. ouallensis*, *D.* (*A.*) *m.* subspecies (Nevis), *P. josephinae nevisensis*). Although similar detailed data were not available to us when writing our study on Dominica (Robinson et al., 2009), we notice a similar pattern: endemic species are predominantly found in the wet vegetation types at higher elevations.

In this context it is interesting to take the protection status of the land snail habitats into account. Helmer et al. (2008) concluded that during 1949–2000 the land cover on both islands has changed dramatically, but a common aspect is that agricultural land (sugar cane plantations) has changed into pasture land. Dry and humid forests increased in area (respectively with 50% for Saint Kitts and 134% for Nevis respectively) during this period. Proportional increases in drier formations at lower elevations were larger than those in evergreen formations at higher elevations. The degree of (formal) protection, however, varies for different categories, ranging from 100% for Evergreen Forest to 0% for lowland Drought (Semi-)Deciduous Forest (Helmer et al., 2008, table 5). Gardner (2006) showed that institutional frameworks for area protection and protected area programs are hardly developed on the islands. As pressure for land development is greatest at lower elevations (Helmer, 2004), lowland drought shrubland and forest are not well protected. Hence snail species occurring there may be vulnerable to habitat fragmentation or destruction. Lugo et al. (2011) suggested that, due to land cover changes in built-up and degraded lands, introduced taxa may have a competitive edge at lowland elevations. From the data presented on the lowland species, *Bulimulus gittenbergeri* especially may be considered as vulnerable when judged against the IUCN-criteria of Critically Endangered species (IUCN, 2012).

In a recent study, Horwith and Kindsay (1999) stated that data on invertebrates were very limited and information useful to conservation planning was lacking. This void is filled herein for the land snail fauna of these two islands.

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